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A certain part of the Index to Vol. XVI has inadvertently been omitted from No. 8 of the Journal. This corrected sheet should, therefore, be substituted for page xiii of the Index when binding the volume.

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JOURNAL OF FORESTRY

VOL. XVI JANUARY, 1918 NO. 1

FOREST TERMINOLOGY

TERMS USED IN THE LUMBER INDUSTRY

Prepared by a Committee of the Society of American Foresters

[Letters in parentheses following definitions indicate the forest region in which the terms as defined are used.]

(Gen.) = General = In all forest regions of the United States.
(C. H. F.) = Central Hardwood Forest.
(App.) = Appalachian Forests.
(L. S.) = Lake States Forests.
(N. W.) = North Woods.
(R. M. F.) = Rocky Mountain Forests.
(Cal.) = California Forests.
(E. C.) = Eastern Canada Forests.
(N. F.) = Northern Forests.
(S. F.) = Southern Forests.
(P. C. F.) = Pacific Coast Forests.
(Log.) = Logging.
(Lum.) = Lumbering.
(Turp.) = Turpentine Orcharding.
(U. K.) = United Kingdom.

Acid wood. Wood suitable for the manufacture of wood alcohol and other products of distillation. (N. F., App.)

Aerial line. *See* Skyline.

Aerial skidder. *See* Cableway skidder.

Air-dried lumber. Lumber which has been seasoned in the open air as contrasted to that seasoned in a dry kiln. (Gen.)

Alder grab. The stem of an alder, or other small tree, which is bent over and plugged into a hole bored in a boom stick or secured in some other way to hold a boom or logs inshore. (N. F.)

Alley. *See* Dingle.

Alligator, *n.* 1. A boat used in handling floating logs. It can be moved overland from one body of water to another by its own power, usually applied through drum and cable. (N. W., L. S.)
2. *See* Go-devil.

Anchor line. A line attached to a small buoy and to one fluke of an anchor used in towing a raft of logs. It is employed to free the anchor when fast to rocks or snags. (N. F.)

Angle bar. A steel plate with a flange base, having from four to six holes through which bolts may be inserted. Two angle bars are used to hold steel rails together at the joints, one angle bar being placed against each side of the web and both bolted to it. (Gen.)

Apron, *n.* (Log.) 1. A platform projecting down-stream from the sluiceway of a dam to launch well into the stream logs which pass through the sluiceway. (Gen.)

2. A platform built of timbers at the foot of a slide, which guides in the desired direction logs leaving the slide. (Gen.)

(Turp.) A galvanized sheet-iron strip which is placed above certain styles of cups and which serves both to support the cup and to guide the crude turpentine into it. (S. F.)

Syn.: tin.

Arbor, *n.* *See* Saw arbor.

Ark, *n.* *See* Wanigan.

Arkansas dry kiln. An early form of kiln consisting of an open box from 16 to 20 feet square with a platform about 8 feet above the ground, on which the lumber is piled. The kiln is open at the top. A fire is built under the platform and heat, sparks, and smoke pass up through the lumber, which gradually becomes dry. (S. F.)

At the base. When referring to the diameter of standing timber, a term used in timber contracts meaning at the ground as contrasted to the usual custom of measuring at the stump. (Supreme Court of North Carolina, 54 Southeastern Reporter, 844.)

At the stump. In a timber contract, the point at which the bole is severed from the stump. Local custom as to stump heights governs in case of litigation. (Superior Court of New York, 126 New York State, 234.)

Back, *n.* The upper or convex part of a saw tooth. (Gen.)

Backbone, *n.* A triangular piece of wood which is placed in the apex of a V-box flume. (Gen.)

Back box, *v.* In turpentine orcharding, to cut an additional box or boxes, or to place additional cups on a bled tree during the third or fourth year it is worked. (S. F.)

Backing board. In sawing lumber on a head saw, the last board in the log to which the carriage dogs are attached.

Syn.: dog board (Gen.), back stand (R. M. F.).

Backing chain. A chain used to prevent logging trucks from sliding under the logs. It is used chiefly on long trains where there is a great strain. (P. C. F.)

Back line. *See* Haul back.

Back-spiker, *n.* One of the members of a crew which completes the spiking of a railroad track after the rails have been laid by the steel gang. (Gen.)

Back stand. *See* Backing board.

Bagboom. An open "limber" boom used to impound logs at the mouth of a stream emptying into a lake or similar body of water. The ends are made fast to the shore below the mouth of the stream, and when the boom is filled the ends are brought together and closed, forming a round boom. (L. S.) *See* Round boom.

Ballhooter, *n.* One who rolls or slides logs down a hillside. (App.)

Band mill. 1. A sawmill equipped with a band head-saw. (Gen.)

2. A machine on which band saws are mounted. (Gen.)

Band saw. An endless, beltlike blade of steel, toothed on one or both edges, which is used to saw lumber. (Gen.)

Bank, *n.* 1. *See* Landing.

2. The logs cut or skidded in one day above the required amount and held over by the saw crew or skidders, to be reported when the required daily number is not reached. (N. F.)

Bank, *v.* *See* Bank up, to.

Banking gound. *See* Landing.

Bank up, to. To pile up logs on a landing. (Gen.)
Syn.: bank, roll up.

Baptist cone. *See* Cap.

Bar, *n.* (Turp.) The strip of bark left between faces on a tree. (S. F.)

Barge boom. A boom, the upstream end of which is attached to a barge anchored in the stream. It is used on navigable streams (on which permanent works are not allowed) in combination with a fin boom where it is desired to divert logs from one side of the stream to the other. (S. F.)

Bark dray. *See* Ranking jumper.

Barker, *n.* 1. One who peels bark in gathering tanbark. (Gen.)
Syn.: peeler, spudder.
2. A machine used to remove bark from pulpwood.
3. *See* Rosser, 1.

Barking iron. *See* Spud.

Barking saw. *See* Rock saw.

Bark ladder. A platform mounted on a wagon or sled and used in hauling tanbark. (N. F.)

Bark mark. A symbol chopped into the side of a log to indicate its ownership; when used with the end mark it serves as an additional means of identification. (Gen.) *See* Mark.
Syn.: catch mark (L. S.), side mark (N. F.), contramarque (E. C.).

Bark marker. One who cuts the bark mark on logs. (Gen.)

Bark rack. A frame used to hold bark on a sled. (N. W.)

Bark slide. A V-shaped trough used on steep hillsides to slide tanbark down to the roads. (N. F.)

Barnboards. Boards used for barn siding. (L. S.)

Barn boss. One who has charge of the stables in a logging camp. (Gen.)
Syn.: feeder. (N. W.)

Barndoor gate. In a logging dam sluiceway, a swinging door attached by hinges to the side of the sluice which can be thrown across the opening to prevent the outflow of water. (Gen.)

Barrel saw. *See* Cylinder saw.

Base, *n.* Interior trim which is fastened to the walls of a room at the floor line. (Gen.)
Syn.: base-board.

Base-board. *See* Base.

Bastard grain. *See* Plain-sawed.

Batch, *n.* A raft of lumber composed of a number of units. (S. F.)

Batt. *See* Batten.

Batten, *n.* (Lum.) A narrow strip of lumber which is used on buildings to cover cracks in siding or roofing. (Gen.)
Syn.: batt.
(Log.) A log less than 11 inches in diameter, inside bark, at the small end. (Maine.)

Battery, *n.* Two or more donkey engines for dragging logs, set at intervals on a long skid road. A "side" may include a "battery," which in turn may include a roader, a "half-breed" and a yarding donkey. The term is not commonly used. (P. C. S.)

Bean house. The foreman's office at a depot camp. (E. C.)

Beaver, *n.* *See* Swamper; Woodpecker.

Becket, *n.* 1. A large hook, formerly used in loading logs on cars by means of tackle. It is now seldom employed. (P. C. F.)
2. An eye or grommet in a rope through which another rope or cable may play. (Gen.)

Bed a tree, to. To level up the path in which a tree is to fall, so that it may not be shattered. (P. C. F.)

Bed piece. One of the skids placed under a pile of lumber. (N. F.)

Bevel cribbing. Boards beveled on both edges, which are used as siding for a corn crib. (Gen.)

Beveled dress. *See* Spring set.

Bevel siding. A board cut in standard lengths and either 4 or 6 inches wide, which tapers to a thin point on one edge. It is used to cover the sides of buildings. (Gen.) *See* Clapboard; Lap siding.
Syn.: siding, weather board.

Bicycle, *n.* *See* Trolley.

Bigness scale. *See* Full scale.

Big wheels. *See* Logging wheels.

Bilge saw. A cylinder saw, the center of which is of greater diameter than either end. It is used in cutting small cooperage stock. (Gen.) *See* Cylinder saw.

Billet, *n.* A short, round section of a log. (Gen.)

Bill of lumber. An order of lumber. (Gen.)

Binder, *n.* A springy pole used to tighten a binding chain. (Gen.)
Syn.: jim binder.

Binding chain. A chain used to bind together a load of logs. (Gen.)
Syn.: wrapper chain. (N. F.)

Bird's-eye, *a.* A piece of lumber is said to have a bird's-eye figure when numerous circlets are found on its surface. Bird's-eye is found only on plain-sawed lumber of a few species. (Gen.)
Syn.: landscape.

Birl, *v.* To cause a floating log to rotate rapidly by treading upon it. (Gen.)

Bit, *n.* 1. A tooth used in an inserted-tooth saw. (Gen.)
Syn.: inserted tooth, point.
2. The knives used on the cutter heads of surfacing machines to cut a tongue and a groove. (Gen.)

Bitch chain. 1. A short heavy chain with hook and ring, used to fasten the lower end of a gin pole to a sled or car when loading logs. (N. F.)
2. A short, heavy chain connecting the main line and the haul back of a yarding donkey, also serving as a point of attachment for the tackle fastened to the logs. When a cable is used instead of a chain, it is known as a bitch line.
Syn.: butt chain, butt line. (P. C. F.)

Bitch line. *See* Bitch chain, 2.

Black cypress. (Log.) A term used by woodsmen to denote cypress timber of heavy weight. (S. F.)
(Lum.) *See* Red cypress.

Blank, *n.* The rough sawed pieces from which axles, spokes, handles, chair rounds and other turned stock are made. (Gen.) *See* Spoke billet.

Blaze, *v.* To mark, by cutting into trees, the course of a boundary, road, trail, or the like. (Gen.)
Syn.: spot. (N. W.)

Bled timber. Pine trees which have been turpentined. (S. F.)

Block, *n.* 1. A pulley of several types used in power logging to change the direction of haul, or to increase the pulling power. (P. C. F.)
2. *See* Brail.

Block-and-whip. An arrangement of a cable and block, to secure added power for moving logs. The free end of the main cable, bearing a swamp hook, is passed through a block fastened to the log to be moved, and then attached to a stump. When the log has been pulled ahead as far as practicable, the cable and swamp hook are moved forward to another stump. (P. C. F.) *See* Block hold.

Block hold. An arrangement of cables and blocks to secure added power for moving logs. The free end of the main cable is passed through a block, attached to the log to be moved, and then fastened to some stationary object. Power is then applied to the opposite end of the cable. Two-block and three-block holds differ in that two or three blocks respectively are attached to the object to be moved. (P. C. F.) *See* Block-and-whip.
Syn.: one-block hold.

Block setter. One who operates the set works on a sawmill carriage. (Gen.)
Syn.: ratchet setter, setter.

Block tender. *See* Chaser.

Blow down. *See* Windfall.

Blower dry kiln. A dry kiln in which the air is heated by steam coils located outside of the drying room, and is forced into the latter by means of a fan. (Gen.)

Blued lumber. Lumber, the sapwood of which has been stained by fungi. (Gen.) *See* Sap stain.

Blue jay. *See* Road monkey.

Bluing, *n.* The result of fungous attack, which turns the sapwood of certain trees blue. (Gen.)

Board, *n.* **1.** A piece of sawed lumber 1 inch in thickenss and varying in width, usually by even inches, from 4 to 12 inches. A term sometimes applied to boards of all widths.
2. Lumber 8 feet or more in length, 6 inches or more in width and up to but not including 1½ inches in thickness. (English markets.)

Board dog. *See* Carriage dog.

Board foot. A unit of measure in the lumber trade. A board foot is a section 12 by 12 inches in size and 1 inch thick, or its equivalent. (Gen.)

Board mill. A sawmill that makes a specialty of 1-inch and 2-inch lumber, as compared to a timber mill that makes a specialty of material of greater thickness. (Gen.)

Board up, to. To place a spring board in position. (P. C. F.)

Bob, *n.* A single pair of runners on which the forward end of logs are loaded. (L. S., N. W.)
Syn.: sloop. (E. C.)

Bobber, *n.* *See* Deadhead.

Bob logs, to. To transport logs on a bob or dray. (N. F.)

Body wood. Cord wood cut from those portions of the stems of trees which are clear of branches. (N. F.)

Bolster, *n.* *See* Bunk.

Bolt, *n.* A segment sawed or split from a short log. A term usually applied to blocks from which shingles, staves, and vehicle stock are manufactured. (Gen.)
Syn.: shingle bolt, stave bolt, spoke bolt.

Bolt buggy. A one-horse four-wheeled vehicle used in hauling stave bolts from a stave mill to the yard, and vice versa. (S. F.)

Bolter, *n.* **1.** A machine consisting of one or more circular rip saws for cutting small squares from slabs and lumber. Often used at hardwood plants to manufacture rough vehicle, furniture, and similar stock. (Gen.) *See* Knee bolter.
2. One who splits stave bolts from a stave-cut. (Gen.)

Bolt rustler. In a stave factory, one who loads stave bolts on trucks for transportations to the equalizer. (Gen.)

Boom, *n.* Logs or timbers fastened together end to end and used to hold floating logs. The term includes the logs inclosed, as a boom of logs. (Gen.)

Boomage, *n.* Toll for use of a boom. (Gen.)

Boom buoy. *See* Boom stay.

Boom company. A corporation engaged in handling floating logs, and owning booms and booming privileges. (N. F.)

Boom chain. A short chain which fastens boom sticks end to end. (Gen.)
Syn.: toggle chain. (P. C. F.)

Boom man. *See* Pond man.

Boom pin. A wooden plug used to fasten to boom sticks the chain, rope, or withe which holds them together. (Gen.)

Boom rat. One who works on a boom. (N. F.)

Boom stay. A heavy weight used to anchor booms in deep water; its position is indicated by a pole or float attached to it.
Syn.: boom buoy.

Boom stick. A timber which forms part of a boom. (Gen.)

Bottle butted. *See* Swell butted.

Bottom, *n.* The lower tier or layer of logs in a joint, usually fastened together by boom poles and pins. (E. C.)

Bottom loader. *See* Ground loader.

Bottom sill. *See* Mudsill.

Bow man. The log driver who sits in the forward end of a bateau.

Box, *n.* (Turp.) A reservoir cut into the base of a pine tree, in which crude turpentine is collected. (S. F.)
(Log.) *See* Undercut.

Box, *v.* *See* Notch.

Box a log, *v.* To throw a log from the log trough onto the mill deck, by means of a log kicker. (P. C. F.)

Box boards. Lumber from which boxes are manufactured. In some grading rules a specific quality of lumber. (Gen.) *See* Wagon box boards.

Box dolly. A lumber-carrying truck which has a single wide-tired wheel in the center of the box frame. Used in loading lumber on vessels. (S. F.)

Boxing ax. *See* Turpentine ax.

Box shooks. Pieces of lumber cut to size for boxes, but which have not yet been made into a box. (Gen.)
Syn.: shook.

Box the heart, *v.* In sawing timbers in a sawmill, to cut boards from all sides of the heart, leaving the center as a piece of timber. (Gen.)

Bracket boom. A stiff boom, three or four logs wide, the logs being fastened together by short boards placed crosswise and spiked, or by transverse poles fastened by wooden pins, withes, chains, or spikes. (Gen.)

Bracket gate. *See* Needle gate.

Brail, *n.* A section of a log raft, six of which make an average tow. (L. S.)
Syn.: block. (S. F.)

Brail, *v.* To fasten logs in brails.

Brake sled. A logging sled so constructed that, when the pole team holds back, a heavy iron on the side of each runner of the forward sled is forced into the roadbed. (N. F.)

Brand, *n.* *See* Mark.

Break, *n.* A draw-bench used to hold a shingle slab while it is being worked with a draw-knife into a hand-rived shingle. (S. F.)

Break down, *v.* 1. To reduce large logs to a size which can be sawed on the main log saws in a sawmill. (P. C. F.)
2. To cut a log into cants. (P. C. F.)
3. To stop a mill or machine because of an accident. (P. C. F.)

Break in a landing, to. To roll logs from the landing into a stream. (R. M. F.)

Break out, to. 1. To start a sled whose runners are frozen to the ground. (N. W., L. S., N. W.)
2. To open a logging road after a heavy snowfall. (N. W., L. S.)

Breastwork log. *See* Fender skid.

Briar, *n.* A crosscut saw. (Gen.)

Briar dress. *See* Spring set.

Bridle, *n.* 1. A device for controlling the speed of logs on a skid road. It consists of a short rope with two hooks at one end, which are driven into the first log of the turn: at the other end is a clamp which runs over the cable. (P. C. F.)
2. A device for controlling the speed of logging sleds. It consists of a chain or clevis placed around the forward end of the rear sled runners. (N. W.)

Bridle man. One who follows a turn of logs down the skid road and tends the "bridle." (P. C. F.)

Bright sap. Sap which is not stained. (Gen.)

Broadleaf, *a.* *See* Hardwood.

Brow, *n.* *See* Landing.

Brow skid. 1. The chief beam in a frame to which tackle for loading logs on cars is fastened where a gin pole is not used. (P. C. F.)
Syn.: draw skid, lead log.
2. A large log, placed parallel with the railroad track, which forms the front part of a landing used for loading logs onto cars. (P. C. F.)

Brush. *See* Slash.

Brush a road, to. To cover with brush the mudholes and swampy places in a logging road, to make it solid. (N. F.)

Brusher, *n.* On an operation where stave bolts are being made, one who cuts and piles limbs from felled trees. (S. F.)

Brush out, to. To clear away the brush from a survey line, gutter road or other logging road. (Gen.)
Syn.: bush out, to.

Brush snow fence. A snowbreak to protect a logging road; used most commonly on wide marshes. It consists of brush which is set upright in the ground before it freezes. (N. F.)

Brutting crew. A crew which rolls logs down slopes too steep for teams. (App.)

Buck, *n.* *See* Chore boy.

Buck, *a.* (Turp.) A term usually applied to a cup or box during the third season the tree is bled. Occasionally the term is applied to cups or boxes during the second season. (S. F.)

Buck, *v.* 1. To saw felled trees into logs. (P. C. F., N. W.)
2. To bring or carry, as to buck water or wood. (Gen.)
3. In hewing half-moon cross-ties, the stick of timber is hewed to a size of 67 x 12 inches and is then "bucked" or split with a broadax into two half-moon ties. (S. F.)

Bucker, *n.* 1. One who saws felled trees into logs. (P. C. F., R. M. F.)
Syn.: cross-cutter (P. C. F.), log maker (S. F.).
2. One who brings or carries. *See* Buck, *v.*

Bucking board. A spring board used in bucking large timber. (P. C. F.) *See* Spring board.

Bucking chute. A short pole chute at a landing, in which double-length logs are bucked before being loaded. (Cal.)

Buck swamper. *See* King swamper.

Buckwheat, *v.* *See* Hang up, to

Buckwheater, *n.* A novice at lumbering. (Gen.)

Buffer. *See* Bumper.

Buggy. (Log.) *See* Trolley.
(Lum.) *See* Lumber buggy; Trolley.

Bull chain. (Lum.) 1. *See* Jack chain.
2. An endless chain traveling in a trough between the sawmill pond and log deck and used to bring logs into a sawmill. A log is attached to the bull chain by means of a short chain having a hook at one end which is caught in a link of the bull chain and two log dogs at the other end which are driven into the log.
(Log.) A chain wrapped around the first log of a turn in order to check the speed. (App.)

Bull block. A very heavy yarding block for use with large donkey engines, having a throat of sufficient width to allow a choker and butt chain to pass through it. (P. C. F.)
Syn.: butt chain block, jumbo, lead block, Tommy Moore.

Bull bucker. *See* Saw boss.

Bull chain. A chain wrapped around the first log of a turn in order to check the speed. (App.)

Bull cook. *See* Chore boy.

Bull donkey. *See* Roader.

Bull edger. *See* Rift gang edger.

Bull head, *v.* A term used by saw filers to denote the action of a saw when it leads in or out of a cut. (Gen.)

Bull load. A turn of logs ready for hauling with a road engine. (P. C. F.)

Bully, *n.* *See* Camp foreman.

Bull wheel. *See* Log turner.

Bummer, *n.* A small truck with two low wheels and a short pole, used in skidding logs. (N. F., S. F.)
Syn.: dolly (L. S., R. M. F.), drag cart, self-loading skidder, skidder.

Bumper, *n.* In a sawmill, a device placed at each end of the carriage run to absorb the shock of the carriage when it has traveled to the extreme end of the track. It may consist of a piston and a very strong coil spring, or it may be a piston fitted with a cylinder which contains live steam or compressed air. (Gen.)
Syn.: buffer.

Bunch, *v.* To skid logs together at some convenient point for wagon or cart hauling. (Gen.)

Bunching ground. (Turp.) A place in the woods where the cups are stacked previous to cup hanging. (S. F.)

Bunch load, to. To encircle several logs with a chain and load them at once by steam or horse power. (N. F.)

Bunch logs, to. To collect logs in one place for loading. (Gen.)

Bunch team. A team used to bunch logs. (Gen.)

Bunk, *n.* 1. The heavy timber upon which the logs rest on a logging sled. (N. F.)
Syn.: bolster.
2. The cross-beam on a log car or truck on which the logs rest. (Gen.)
3. A log car or truck. (S. F., P. C. F.)
4. A logger's bed in a lumber camp. (Gen.)

Bunk, *v.* To place upon the bunks, as to "bunk a log." (Gen.)

Bunk chain. *See* Toggle chain.

Bunk hook. The hook attached to the end of the bunk on a logging car, which may be raised to hold the logs in place or lowered to release them. (Gen.)

Bunkhouse, *n.* The sleeping quarters of a logging crew. (Gen.)

Bunk load. A load of logs not over one log deep, *i. e.*, every log rests on the bunks. (Gen.)

Bunk spikes. Sharp spikes set upright in the bunks of a logging sled to hold the logs in place. (N. F.)

Burner, *n.* *See* Refuse burner.

Burton, *n.* In logging, a tackle composed of two or more blocks which is used to increase the hauling power of the pulling line. The log is attached to a block in the bight of the running part. (P. C. F.)

Bush a road, to. To mark the route of a logging road across a marsh or the ice by setting up bushes. (N. F.)

Busher, *n.* *See* Swamper.

Bush monkey. One who piles tanbark in a California forest. (P. C. F.)

Bush out, to. *See* Brush out, to.

Butt, *n.* The base of a tree, or the big end of a log. (Gen.)

Butt, *v.* *See* Trim.

Butt chain. *See* Bitch chain.

Butt chain block. *See* Bull block.

Butt cut. 1. The first log above the stump. (Gen.)
Syn.: butt log. (Gen.)
2. In gathering tanbark, the section of bark taken from the butt of a tree before felling it for further peeling. (N. F.)

Butt hook. The hook by which the cable is attached to the tackle on the logs. (P. C. F.)

Butting saw. *See* Cut-off saw.

Butt line. *See* Bitch chain.

Butt log. *See* Butt cut.

Butt off, to. 1. To cut a piece from the end of a log on account of a defect. (Gen.)
Syn.: log butt, to. (P. C. F., App., N. W.)
2. To square the end of a log. (N. F.)

Buttress, *n.* A wall or abutment built along a stream to prevent the logs in a drive from cutting the bank or jamming. (Gen.)
Syn.: crib. (App.)

Butt saw. *See* Cut-off saw; Drag saw.

Butt-saw man. On a timber dock, one who operates a butt saw. (Gen.)

Butt team. *See* Wheelers; Snub-yoke.

Byrkit lath. A patent backing for plaster which is made from low-grade lumber manufactured into a special pattern. (Gen.)
Syn.: patent lath, sheathing lath.

Cableway skidder. A power skidding device, a distinguishing feature of which is a main cable suspended between a head-spar tree and a tail tree on which the trolley travels which wholly or partially elevates the logs from the ground. (Gen.)
Syn.: aerial skidder, flying machine. (P. C. F.)

Cache, *n.* A storehouse for logging camp supplies. (E. C.) *See* Headquarters.

Caliper measure. A method of measuring square or roughly hewn logs. The thickness and breadth of the log is calipered at the middle and the cubic content determined as follows: $\frac{B \times T \times L}{144} = C$, in which B equals the breadth, T the thickness, L the length, and C cubic feet content. All breadth and thickness measurements are taken to the nearest one-fourth inch. Length measurements for logs containing less than 5 cubic feet are taken to the nearest one-fourth foot, and the contents to the nearest one-tenth cubic foot; logs containing more than 5 cubic feet, 8 inches square or under $10\frac{1}{2}$ feet in length, have their length measured to the nearest one-half foot and the cubic

content calculated to the nearest one-half cubic foot, while logs over 9 inches square and more than 10½ feet long have their length measured to the nearest one-half foot, with all fractional cubic feet rejected. (U. K.)
See Hoppus String Measure; Liverpool String Measure.

Camboose, *n.* A fireplace in the center of the early logging camps of Eastern Canada, which served both for cooking and for heating purposes. (E. C.)

Camp car. A flat car equipped with seats and used to haul loggers back and forth between camp and the logging operation. (P. C. F.)
Syn.: cattle car, mulligan car (P. C. F.)

Camp foreman. One who has charge of a logging camp and the logging operations conducted from that camp. (Gen.)
Syn.: bully (N. F.), push (P. C. F.), twister (App.), shanty boss (E. C.).

Camp inspector. A lazy lumberjack who goes from one logging camp to another, working only a short time in each. (N. F.) *See* Pouch.
Syn.: rodeur. (N. C.)

Canary, *n.* An iron rod about six feet long with a hook on one end and a handle on the other. It is used to pull the binding chain under a bundle of logs that are to be loaded on logging wheels. (L. S.)

Cannon a log, to. In loading logs by steam or horse power, to send up a log so that it swings crosswise instead of parallel to the load. (N. F.)
Syn.: gun a log, to. (R. M. F.)

Cant, *n.* A log which has been slabbed on one or more sides. (Gen.)

Cant a log, to. To remove slabs from one or more sides of a log. (Gen.)

Cant dog. A short-handled peavey. (Gen.)

Cant flipper. In a sawmill, two or more horizontal bars placed in a line of live rolls; the outer ends are fastened to a common shaft attached to the piston of a steam cylinder, and the near ends are pivoted to a firm support. On elevating the outer ends, cants and boards are transferred at right angles to direction of travel to a temporary storage point behind the gang saw, resaw, or edger. (Gen.)

Cant hook. A tool like a peavey, but having a toe ring and lip at the end instead of a pike. (Gen.) *See* Peavey.

Cant setter. In a sawmill, one who places the cants in position for the gang saw. (Gen.)

Cap, *n.* A cone of sheet iron or steel, with a hole in the apex through which a chain passes, which is fitted over the end of a log to prevent catching on stumps, roots, or other obstacles in steam skidding. (S. F.)
Syn.: Baptist cone.

Captain. A term applied by negro workmen to the foreman of any crew. (S. F.)
See Saw boss; Team boss.

Carriage, *n.* (Lum.) A frame on which are mounted the head blocks, set works, and other mechanism for holding a log while it is being sawed, and also for advancing the log towards the saw line after a cut has been made. The carriage frame is mounted on trucks which travel on tracks, the carriage being actuated by a steam feed, cable or rack-and-pinion device, which propels it back and forth past the head saw. (Gen.)
Syn.: saw carriage.
(Log.) *See* Trolley.

Carriage dog, *n.* A steel tooth-like projection, several of which are attached to a carriage knee and operated by a lever. Carriage dogs are used to hold the log firmly on the carriage. (Gen.)
Syn.: board dog (P. C. F.), dog.

Carriage feed. A device used to drive the sawmill carriage back and forth. It may consist of a rack and pinion, a cable and sheaves, or a large steam cylinder equipped with a piston which actuates the carriage. In large mills the steam cylinder is used for short carriages and the cable for long carriages. In portable mills the rack and pinion or the cable feed is used. (Gen.)

Carriage offset. *See* Carriage receder.

Carriage receder. A device on the underside of a sawmill carriage which, on the gig back of the carriage, automatically shunts the carriage frame on its axles about five-eights inch away from the saw line. The carriage receder is employed only in band sawmills and its use prevents the log tearing the band saw from the wheels. (Gen.)
Syn.: carriage offset.

Carriage rider. *See* Dogger.

Carriage trailer. An extension section of a log carriage which may be attached or detached at will. The carriage trailer permits the sawing of long logs on a comparatively short carriage. (Gen.)

Case harden. In seasoning lumber, a piece is said to be case hardened when the exterior becomes very dry while the interior remains moist. This is usually due to the application of a high degree of heat in a short time. (Gen.)

Casing, *n.* A form of interior trim used for window and door cases. (Gen.)

Catamaran, *n.* A small raft carrying a windlass and grapple, used to recover sunken logs. (Gen.)
Syn.: sinker boat (Gen.), gunboat, monitor, pontoon (P. C. F.).

Catch boom. A boom fastened across a stream to catch and hold floating logs. (Gen.)
Syn.: trap boom.

Catch mark. *See* Bark mark.

Caterpillar. *See* Log hauler.

Catface, *n.* A partly healed-over fire scar on the stem of a tree. (Gen.)

Catpiece, *n.* A small stick, in which holes are made at regular intervals, placed on the top of uprights firmly set in floating booms. The uprights are fitted to enter the holes in the catpiece so as to narrow or widen the space between the booms at the entrance to a sluiceway or sorting jack. The catpiece is held by the uprights high enough above water to allow logs to float freely under it. (N. W., L. S.)

Cattle car. *See* Camp car.

Cattyman, *n.* An expert river driver. (N. F.) *See* River rat.

Ceiling, *n.* A pattern of lumber, usually finished on one side only, which is used for wainscoting, ceiling, and like purposes. (Gen.)

Center head. (C. B.) A partition or ceiling strip that has a bead pattern running lengthwise through the center. (Gen.)

Center jam. A jam which is formed on an obstacle in the middle of a stream and does not reach either shore. (Gen.)
Syn.: stream jam.

Center-sawed. *See* Quarter-sawed.

Chainer. *See* Sled tender.

Chain grapples. *See* Grapples.

Chain sorter. One who pulls lumber from the sorting table of a sawmill and piles it on trucks or other vehicles for transportation to the dry kilns or drying yards. (Gen.)
Syn.: sorter.

Chain tender. *See* Sled tender.

Chamber, *n.* *See* Throat.

Chamber, *v.* *See* Gum.

Chambering machine. *See* Gummer.

Chance, *n.* 1. A term used to define the ease or difficulty with which a particular logging operation or part of an operation can be conducted. A good "chance" is one where conditions are favorable for easy logging. (N. F.)
Syn.: show. (P. C. F.)
2. A logging unit. (Gen.)

Chaser, *n.* 1. A member of the hauling crew on a skidroad who accompanies the turn of the logs to the landing, unhooks the grabs, and sees that they are returned to the yarding engine. (P. C. F., R. M. F.)
Syn.: frogger, sled tender (Cal.), pigman (P. C. F.).
2. A member of the yarding crew who tends a bull block, unhooks the choker at the landing, and sees that it is returned to the woods. (P. C. F.)
Syn.: block tender. (Cal.)

Check, *n.* A longitudinal crack in timber caused by too rapid seasoning. (Gen.)
Syn.: seam, season check.

Checker, *n.* One who counts the number of pieces of lumber as it is loaded on a vessel or into a car. (Gen.) *See* Tallyman.

Check scaler. One who re-scales logs in order to detect errors on the part of the regular scaler. (Gen.)

Cheese block. *See* Chock block.

Chickadee, *n.* *See* Road monkey.

Chimney, *n.* An opening left from top to bottom of a lumber pile to facilitate the circulation of air and hasten seasoning. (Gen.)

Chink, *v.* To close the crevices between the logs in a logging camp with wood or moss. (N. W.)
Syn.: moss (N. F.), stog (E. C.). *See* Daub; Mud.

Chip, *n.* 1. The narrow portion of sapwood which is removed from above the box of a tree which is being held for crude turpentine. (S. F.)
2. The refuse strained from scrape. *See* Dross.

Chip, *v.* (Turp.) To cut away a thin section of sapwood above the box or cup in order to stimulate the flow of crude turpentine. The wood so removed is called chip. (S. F)
Syn.: hack.

Chip breaker. A pressure bar in front of the cutter knives in a planing machine which is designed to prevent splinters from being torn from the face of a board as it passes through the machine. (Gen.)

Chipped grain. A machine defect in surfaced lumber, the grain of the wood having been torn out in small particles by the action of the planer knives. (S. F., P. C. F.)

Chipper, *n.* (Turp.) One who chips. (S. F.)
(Lum.) *See* Hog.

Chipper and notcher. The chief of several saw crews. He notches the timber and keeps a tally of the number of logs cut by each saw crew. (S. F.)

Chock block. 1. A small wedge or block of wood used to prevent a log from rolling. (Gen.)
Syn.: cheese block. (P. C. F.)
2. A device used on patent log car bunks to prevent logs from rolling off. (P. C. F.)

Choker, *n.* A noose of wire rope by which a log is dragged. The rope is from 20 to 50 feet in length and has a choker hook on one end and a braided eye on the other. (P. C. F.)

Choker-hole digger. *See* Gopher.

Choker hook. A hook fastened to one end of a choker, in which the cable is caught where the choker is adjusted around the log in the form of a noose. (Gen.)

Choker man. The member of a yarding crew who fastens the choker on the logs. (P. C. F., R. M. F.)

Chopper, *n.* *See* Faller.

Chopping board. *See* Spring board.

Chore boy. In a logging camp, one who cleans up the sleeping quarters and stable, cuts firewood, builds fires, and carries water. (Gen.)

Syn.: lobby hog (App.), shanty boss, swamper (N. W.), buck, bull cook, flunky, greaser.

Christiana standard. A European lumber measurement based on a piece 1¼ inches by 9 inches in cross section by 11 feet in length, equal to 10 5/16 feet board measure. One hundred and twenty (120) standards are known as a Christiana standard hundred, equal to 1,237½ feet board measure.

See Drammen standard, London standard, Quebec standard, St. Petersburg standard.

Christiana standard hundred. *See* Christiana standard.

Chuck up, to. *See* Chunk up, to.

Chuck, *v*. To clear the ground, with engine or horses, of obstructions which can not be removed by hand. (P. C. F.)

Chuck bucker. One who, in advance of felling, bucks up merchantable windfalls and also other down timber which may interfere with yarding. (P. C. F.)

Chunk up, to. 1. To collect and pile for burning the slash left after logging. (N. W., L. S.)

2. In burning brush, to throw onto the fire the unburned pieces around the edge of the pile. (P. C. F.)

Syn.: chuck up, to.

Churn butted. *See* Swell butted.

Chute, *n*. A trough built of round timber in which logs are transported up or down a grade, either by animal power or by gravity. (E. C., P. C. F.)

Syn.: slide, flume.

Chute boat. *See* Rigging sled.

Chute grease. A heavy oil applied to skids to lessen the friction of logs dragged over them. (P. C. F.)

Syn.: skid grease.

Chute greaser. *See* Greaser.

Cinch line. *See* Swifter.

Circular gang mill. A machine having a battery of circular saws, from 22 inches to 26 inches in diameter, all of which are fitted to the same shaft. They are usually spaced to cut 1-inch flooring strips from 4-inch or 6-inch cants. These saws are sometimes mounted on one end of the edger arbor. (Gen.)

Circular saw. A circular plate having cutting teeth on the circumference. (Gen.) *See* Solid-tooth circular saw.

Syn.: rotary saw.

Circular sawmill. 1. A sawmill that has a circular head saw. (Gen.)

2. The mechanism which drives a circular head saw. (Gen.)

Clamp, *n*. In fluming lumber, a short iron bar with recurved ends which is used to bind several boards together into a bundle. (Cal.)

Clapboard, *n*. A quarter-sawed board, either 4 or 6 inches wide and 4 or 6 feet long, which tapers to a thin point on one edge. It is used to cover the sides of buildings. (N. F.) *See* Bevel siding; Lap siding.

Cleaner. *See* Raker.

Clean-up man. One who cleans up the refuse in a sawmill or planing mill. (Gen.)

Clear lumber. Lumber practically free from all defects. (Gen.)

Clip, *v*. *See* Trim.

Clipped board. A board which has been trimmed square on the end. (Eastern markets.)

Clipperman, *n*. One who operates a shingle machine. (P. C. F.)

Club spoke. A partially completed spoke without a tenon or finish. (Gen.)

Coal off, to. To cut a forest clean for charcoal wood. (N. F.)

Coarse grain. As applied to the grain of lumber, that which has wide annual rings. (Gen.)

Coffee mill. *See* Corkscrew.

Comb-grained. The best quality of quarter-sawed lumber, the growth rings of which are nearly or quite at right angles to the face of the board. (Gen.) *See* Quarter-sawed.

Commissary, *n.* A general store for supplying lumbermen. (App., S. F.) *See* Van.

Common boards In southern yellow pine, the term applied to four grades of 1-inch lumber of a quality inferior to finishing lumber. The widths run, by even inches, from 8 to 12 inches. In Pacific Coast woods the widths range, by even inches, from 4 to 12 inches.

Common dimension. In southern yellow pine 2-inch stock ranging, by even inches, from 4 to 12 inches in width. In Pacific Coast lumber, 2-inch stock ranging, by even inches, from 4 to 12 inches in width, and 3-inch stock ranging, by even inches, from 6 to 12 inches in width.
Syn.: dimension.

Compound wood. *See* Laminated wood.

Concave saw. A circular saw, concave in form, which is used to cut chair, cooperage, and vehicle stock. (Gen.)

Conk, *n.* 1. The decay in the wood of trees caused by a fungus. (N. F., P. C. F.)
2. The visible fruiting organ of a tree fungus. (N. F., P. C. F.)

Conky, *a.* Affected by conk. (N. F., P. C. F.)

Connected truck. *See* Skeleton log car.

Constantine inspection. *See* Constantine measure.

Constantine measure. A system of log measurement in the New York market used in measuring square hewed foreign woods, chiefly mahogany and cedar logs. From first-class hewed timber, there is deducted 2 inches width from one face and 1 inch from the other face at right angles to it, this deduction being made to straighten the log and to remove ax marks. The face measurements are then used to compute the cubical contents of the log. If the log is defective the contents are reduced one-half.
Syn.: Constantine inspection.

Contramarque. *See* Bark mark.

Converter poles. Small poles which are used in the refinement of copper. They are thrust into the molten metal and the resulting carbonization of the wood aids in the removal of impurities. (Gen.)

Cook camp. The building used as kitchen and dining room in a logging camp. (Gen.)
Syn.: cook house, cook shanty.

Cookee, *n.* A cook's helper and dishwasher in a logging camp. (Gen.) *See* Flunky.

Cook house. *See* Cook camp.

Cook shanty. *See* Cook camp.

Corduroy, *v.* To build a corduroy road. (Gen.)

Corduroy road. A roadway having logs laid side by side across it, as in marshy places. (Gen.)

Corkscrew, *n.* A geared logging locomotive. (P. C. F.)
Syn.: coffee mill (N. W.), stem winder, thousand legs (App.).

Corner, *v.* (Log.) In felling timber, to cut through the sapwood on all sides to prevent the latter from splitting. (App.)
(Turp.) In turpentine orcharding, to cut the two flat faces above the box. (S. F.)

Corner binds. Four stout chains used on logging sleds to bind the two outside logs of the lower tier to the bunks and thus give a firm bottom to the load (N. F.)

Corner man. In building a log camp, one who notches the logs so that they will fit closely and make a square corner. (N. F.)

C. I. F. A marine shipping term, "cost, insurance, and freight," meaning that the seller delivers the goods to the carrier and agrees to pay all charges to bill-of-lading destination. On delivery, to buyer, of bill-of-lading with insurance policy attached the seller's responsibility ceases.

C. I. F. E. Cost, insurance, freight, exchange. (Gen.)

Coupling grab. *See* Grapples.

Course, *n.* A single layer of boards in a pile of lumber. (Gen.)
Syn.: round.

Cove siding. *See* Drop siding.

Cover up logs, to. To fell trees on top of those already cut. (N. F.)

Crab, *n.* *See* Headworks.

Cradle, *n.* A framework of timbers in which ocean-going log rafts are built. (P. C. F.)

Cradle knolls. 1. Small knolls which require grading in the construction of logging roads. (N. W., L. S.)
2. Small knolls which must be avoided in pointing a tree for felling. (P. C. F.)

Crazy chain. The short chain used to hold up that tongue of a sprinkler sled which is not in use. (N. F.)

Crazy dray. *See* Go-devil.

Creek. *See* Float road.

Crib, *n.* 1. Specifically, a raft of logs; loosely applied to a boom of logs. (N. F.)
2. *See* Buttress.
3. One of the supports under a logging bridge, flume, or railroad built of round logs laid crib fashion. (Gen.)

Crib dam. A dam built with cribs of logs, filled with stones, and planked on the up-stream face. (Gen.)

Crib logs, to. To surround floating logs with a boom and draw them by a windlass on a raft (a crab), or to tow them with a steamboat. (N. W., L. S.)

Crop, *n.* In turpentine orcharding a working unit comprising the number of cups or boxes worked by a chipper. A crop may consist of any number of cups or boxes, ranging from 6,000 to 10,500. (S. F.)

Cross chains. Chains connecting the front and rear sleds of a logging sled. (N. F.)
Syn.: lead chains. (N. W.)

Cross-cut, *v.* To cut a board or timber at right angles to the general direction of the fibres. (Gen.)

Cross-cut saw. A saw which cuts the wood fibres on the cross section. (Gen.)

Cross-cutter. *See* Bucker.

Cross grain. As applied to the grain of lumber, a piece in which the wood elements interweave and are not constant in any one direction. (Gen.)
Syn.: spiral grain.

Cross haul. The cleared space in which a team moves in cross hauling. (N. F.)
2. *See* Crotch chain.

Cross haul, to. To load cars or sleds with logs by horsepower and crotch or loading chains. (Gen.)

Crotch, *n.* *See* Go-devil.

Crotch, *v.* To cut notches on opposite sides of a log near the end, into which dogs are fastened. (P. C. F.)

Crotch chain. A tackle for loading logs on sleds, wagons, cars, or skidways by cross hauling. (Gen.)
Syn.: cross haul (S. F.), parbuckle (N. W.).
See Loading chain.

Crotch tongue. Two pieces of wood, in the form of a V, joining the front and rear sleds of a logging sled. (N. W., L. S.)

Croze, *n.* 1. The cross groove in the staves of cooperage in which the edge of the head is inserted. (Gen.)
2. A circular hand plane or a machine for cutting the croze in staves. (Gen.)
Syn.: crozer.

Crozer. *See* Croze.

Crude turpentine. The resinous substance which exudes from the wounds of certain pine trees, and from which turpentine and rosin are secured by distillation. (S. F.)
Syn.: dip, gum, resin, soft gum.

Cruise, *v.* To estimate the amount and value of standing timber. (Gen.)
Syn.: estimate, value.

Cruiser, *n.* One who cruises. (Gen.)
Syn.: estimator, land looker, valuer.

Cubic foot average. In export shipments of southern yellow pine timbers, a term used to denote the average cubic-foot contents of all pieces in the shipment. (S. F.)

Cull, *n.* 1. (Log,) Logs which are rejected, or parts of logs deducted in measurement on account of defects. (Gen.)
2. A cross-tie which does not meet the specifications. (Gen.)

Cull, *v.* (Log.) *See* Scale.
(Lum.) *See* Grade.

Cull or Peck. A grade of cypress comprising pieces below No. 2 common and also those cut from the "pecky" part of a log. (S. F.)

Culler, *n.* 1. (Lum.) One who assorts staves as they leave the saw. (S. F.)
2. *See* Grader.
(Log.) *See* Scaler.

Cup, *n.* A galvanized sheet-iron or clay receptacle placed on a tree, in which the crude turpentine is caught. (S. F.)

Cupping. In a sawmill, a term applied to the action of a band saw which cuts thick and thin lumber. (Gen.)
Syn.: running.

Cupping ax. (Turp.) A large broadax with a concave cutting edge, used in cutting an incision at the base of the face into which the apron is to be inserted. (S. F.)

Curly grain. As applied to the grain of lumber, pieces in which the fibres undulate but do not cross each other. When the undulations are large, wood is said to be wavy grained.

Custom sawing. The sawing of lumber under contract, usually to given specifications. (Gen.)

Cut, *n.* (Lum.) The output of a sawmill for a given period of time. (Gen.)
Syn.: output.
(Log.) A season's output of logs. (Gen.)

Cut a box, to. To cut a box on a pine tree which is to be bled for crude turpentine. (S. F.)

Cut a log, to. To move one end of a log forward or backward so that the log will roll in the desired direction. (Gen.)

Cutaway dam. *See* Splash dam.

Cut off. An artificial channel by which the course of a stream is straightened to facilitate log driving. (N. F.)

Cut-off man. One who operates a cut-off saw in a sawmill. (Gen.)

Cut-off saw. A circular or band saw used in a sawmill or other woodworking establishment to cross-cut logs, timbers, or boards. (Gen.) *See* Deck saw.
Syn.: butt saw, butting saw.

Cutter, *n.* (Turp.) A three-cornered steel instrument used in sharpening hacks and pullers. (S. F.)
(Log.) *See* Faller.

Cutter head. The shaft of a planing machine on which is mounted one or more cutting knives. (Gen.)

Cylinder saw. A steel shaft and a cast-iron head to which is fastened a steel drum or cylinder, the walls of which are parallel with the mandrel for the entire length. The cutting edge consists of a toothed steel band attached to the free end of the drum. *See* Bilge saw.
Syn.: barrel saw.

Dado-head saw. A grooving saw which can be adjusted to cut any size groove by the insertion of one or more cutter heads between two outside saws of special pattern. (Gen.) *See* Grooving saw.

Daub, *v.* *See* Mud.

Deacon seat. The bench in front of the sleeping bunks in a logging camp. (N. F.)
Syn.: dog seat.

Dead and down. Dead timber which is either standing or down. (Gen.)

Deadener, *n.* A heavy log or timber, with spikes set in the butt end, so fastened in a log slide that the logs passing under it come in contact with the spikes and have their speed retarded. (Gen.)

Dead face. *See* Dry face.

Deadhead, *n.* A sunken or partly sunken log. (Gen.)
Syn.: bobber (N. F.), sinker (Gen.).

Deadman, *n.* 1. A fallen tree on the shore, or a timber to which the hawser of a boom is attached. (N. F., P. C. F.)
2. A log buried in the ground to which a guy line or an anchor line is attached. (Gen.)
3. *See* Widow maker.

Dead rollers. Rollers, used for the handling of lumber, which are not power driven. (Gen.) *See* Live rollers.

Deadwater. *See* Stillwater.

Deal, *n.* 1. In the southern yellow-pine export trade, pieces 9 inches and up in width and 3, 4, or 5 inches in thickness. (S. F.)
2. A piece of any width and 3 inches and up in thickness is known as a "Quebec deal" in English markets. (E. C.)
3. A piece of lumber 12 feet or more in length, from 6 to 11 inches in width and from 2½ to 4½ inhes in thickness. (English markets.)

Deck, *n.* *See* Log deck.

Decker. One who rolls logs up on a skidway or log deck. (Gen.)
Syn.: yard tender (N. W.)

Decking chain. *See* Loading chain.

Decking hook. A light peavey used by a top loader. (App.)

Deck man. In a sawmill, one who keeps straight the logs on the deck and rolls them down for loading on the carriage. (Gen.)

Deck saw. A saw used in cross-cutting logs as they rest in the log trough. (Gen.) *See* Cut-off saw.

Deck scaler. One who scales logs on the deck of a sawmill and also operates the levers controlling the log kicker. (Gen.)

Deck stop. *See* Log stop and loader.

Deck up, to. To pile logs upon a skidway. (Gen.)

Deer foot. A V-shaped iron catch on the side of a logging car, in which the binding chain is fastened. (Gen.)

Dehorn, *v.* To saw off the ends of logs bearing the owner's mark and put on a new mark. (Kentucky.)

Density rule. An authorized and approved set of specifications of the Southern Pine Association under which southern yellow-pine timbers are graded. (Gen.)

Depot, *n.* The headquarters of a logging operation. (E. C.)

Depot camp. A logging camp comprising several buildings which are to be used for more than one year. (E. C.)

Dhobie tongs. Skidding tongs used with bummers. (S. F.)

Dial. *See* Set works scale.

Dimension, *n.* 1. As applied to hardwood lumber, a term loosely used, but generally referring to small squares used for furniture and like purposes. (Gen.) *See* Common dimension.

2. Any lumber cut to size, but especially large timbers cut to order. (E. C.)

Dimension board. *See* Stock boards.

Dimension planer. *See* Sizer.

Dimension shingles. Those which are cut in uniform widths and only one width packed in a bundle. (Gen.)

Dingle, *n.* The roofed-over space between the kitchen and the sleeping quarters in a logging camp, commonly used as a store-room. (N. W., L. S.)
Syn.: alley (N. W.).

Dinkey, *n.* A small logging locomotive. (App., S. F.)

Dip, *n.* *See* Crude turpentine.

Dip, *v.* (Lum.) To immerse in a solution designed to prevent sap stain. (Gen.)
(Turp.) To collect crude turpentine from a box or cup. (S. F.)

Dip barrel. (Turp.) A tight-coopered barrel with a detachable head, in which crude gum from dip buckets is placed for transportation to the still. These barrels hold about 550 pounds gross weight. (S. F.)

Dip bucket. (Turp.) A wooden vessel holding about five gallons, in which dip is placed when taken from cups or boxes. (S. F.)

Dip iron. *See* Dipper.

Dipper, *n.* 1. One who collects crude turpentine from boxes or cups. (S. F.)

2. The tool or paddle with which the workman removes the crude turpentine from the box or cup. (S. F.)
Syn.: dip iron.

Dipping vat. A tank containing a solution into which lumber is dipped in order to prevent sap-stain. (S. F.)

Distribute lumber, to. To take lumber to the yard and leave it at the proper pile. (Cal.) *See* Tram.

Dock, *n.* 1. An elevated structure at the rear of a sawmill on which sawed products are stored and from which they can be loaded into or onto cars or ships by gravity. (Gen.)
Syn.: ramp, timber dock.

2. *See* Dollyway.

Dock man. At a sawmill plant, one who aids in handling timbers on the loading dock.
Syn.: loader, skid man.

Dog, *n.* (Log.) A short, heavy piece of steel, bent and pointed at one end with an eye or ring at the other. It is used for many purposes in logging, and is sometimes so shaped that a blow directly against the line of draft will loosen it. (Gen.) *See* Rafting dog.
Syn.: tail hook. (P. C. F.)
(Lum.) *See* Carriage dog.

Dog board. *See* Backing board.

Dog boat. *See* Rigging sled.

Dogger, *n.* (Log.) One who attaches the dogs or hooks to a log before it is steam skidded. (S. F., P. C. F.)

(Lum.) One who rides on a sawmill carriage and handles a lever which operates the "dogs" that hold the log. The dogger on the forward end of the carriage is sometimes called the "head-end dogger," and the one on the rear end, the "rear-end dogger." (Gen.)

Syn.: carriage rider.

Dogging jaws. *See* Log dog.

Dog hook. **1.** The hook on the end of a dogwarp. (N. F.)

2. In yarding with a line horse, a hook on the end of a haul-up chain of a size to permit its being hooked into a link of the chain when the latter is looped around a log or other object. (P. C. F.)

Dog room. The lounging room in a logging camp. (N. W.)

Dogs, *n.* *See* Skidding tongs.

Dog seat. *See* Deacon seat.

Dogwarp, *n.* A rope with a strong hook on the end which is used in breaking dangerous jams on falls and rapids and in moving logs from other difficult positions. (N. F.)

Syn.: hand dog (N. F.), hand grab (E. C.).

Dog wedge. An iron wedge, with a ring in the butt, which is driven into the end of a log. A chain is hitched into the ring for skidding logs by horse-power. When used in gathering up logs on a drive a rope is run through several rings; in this way a number of logs may be pulled to the channel at one time across marshes or partially submerged meadows. (N. F.)

Dolbeer. *See* Spool donkey.

Dolly, *n.* **1.** (Lum.) A roller set in a square frame on which timbers are placed when they are to be moved by hand from one place to another. (P. C. F.)

Syn.: timber roller.

2. *See* Lumber buggy.

(Log.) *See* Fairleader; Load roller; Bummer.

Dollyway, *n.* An elevated tramway which runs from the sawmill to the drying yard and over which lumber is transported. (Gen.)

Syn.: dock.

Dolphin, *n.* A cluster of piles to which a boom is secured. (P. C. F.)

Donkey, *n.* A portable steam engine, equipped with drum and cable, used in steam logging. *See* Half-breed; Roader; Spool donkey; Yarding donkey. (P. C. F.)

Donkey doctor. In a logging camp, one who repairs donkey engines. (P. C. F.)

Donkey logging. Yarding on the ground with a donkey engine, as contrasted with animal logging, or other power logging methods. (P. C. F.)

Donkey sled. The heavy sled-like frame upon which a donkey engine is fastened. (P. C. F.)

Dote, *n.* The general term used by lumbermen to denote decay or rot in timber (Gen.)

Doty, *a.* Decayed. (Gen.)

Syn.: dozy.

Double circular mill. *See* Top saw.

Double couplers. Two coupling grabs joined by a short cable, used for fastening logs together. (P. C. F., App.)

Syn.: four paws.

Double-cutting band saw. A saw which is toothed on both edges and is designed to saw on both the forward and rear travel of the carriage. (Gen.)

Double dray. *See* Jumbo.

Double header. A place from which it is possible to haul a full load of logs to the landing and where partial loads are topped out or finished to the full hauling capacity of teams. (N. W., L. S.)

Double mill. A sawmill having two head saws. (Gen.)

Dowel, *n.* A wooden pin used to hold together two pieces of wood. They are in common use in the manufacture of sashes, doors, blinds, tight cooperage, heading, and like uses. (Gen.)

Down-hill clevis. A brake on a logging sled, consisting of a clevis encircling the runner, to the bottom of which a heavy square piece of iron is welded. (N. F.)

Dozy, *a.* *See* Doty.

Drag cart. *See* Bummer.

Drag in, to. *See* Dray in, to.

Drag road. 1. A road over which skidding teams return to the woods after having delivered their load at the landing. (R. M. F.) *See* Dray road; Gutter road.

Drag saw. A reciprocating saw blade, driven either by a piston actuated by a steam cylinder or by a walking beam, which is used to cross-cut logs. (Gen.)
Syn.: butt saw.
See Steam bucking saw.

Drag sled. *See* Dray.

Drammen standard. A Norwegian unit of lumber measurement. It is based on a piece 2½ inches by 6½ inches in cross section by 9 feet in length, equal to 12 3/16 feet board measure. One hundred and twenty (120) standards are called a Drammen standard hundred, equal to 1,462½ feet board measure.
See Christiana standard, London standard, Quebec standard, St. Petersburg standard.

Drammen standard hundred. *See* Drammen standard.

Draw hook. *See* Gooseneck.

Draw skid. *See* Brow skid.

Dray, *n.* A single sled used in dragging logs. One end of the log rests upon the sled. (N. F.)
Syn.: drag sled, lizard, scoot, skidding sled, yarding sled.

Dray dog, to. To seize the rear end of a ranking jumper with a peavey and turn it around.

Dray in, to. To drag logs from the place where they are cut directly to the skidway or landing. (N. F.)
Syn.: drag in, to.

Dray road. A narrow road, cut wide enough to allow the passage of a team and dray. (N. F.)
Syn.: drag road.

Dress, *v.* *See* Surface.

Dressed and headed (D. and H.). A flooring strip is dressed and headed when it has been surfaced, tongued, and grooved, and also has a tongue on one end and a groove on the other so that the board need not join over a rafter. (Gen.)

Dressed and matched (D. and M.). Boards which have been surfaced, tongued, and grooved. (Gen.)

Dressed lumber. Lumber which has been dressed or surfaced on one or more sides. (Gen.)

Drift, *n.* In turpentine orcharding, any convenient working unit of a crop. Formerly it comprised 2,100 cups or boxes, five drifts constituting a crop. (S. F.)

Drive, *n.* 1. A body of logs or timbers in process of being floated from the forest to the mill or shipping point. (Gen.)
2. That part of logging which consists in floating logs or timbers. (Gen.)

Drive, *v.* To float logs or timbers from the forest to the mill or shipping point. (Gen.)
Syn.: float.

Driving road. *See* Float road.

Drop siding. A pattern of lumber used to cover the exterior sides of buildings. (Gen.)
Syn.: cove siding, German siding, novelty siding, patent siding, siding (Gen.), rustic siding (P. C. F.).

Dross, *n.* Foreign matter which is strained out of crude turpentine and resin at the still. (S. F.)
Syn.: trash.
See Chip.

Drum logs, to. To haul logs by drum and cable out of a hollow or cove. (App.)

Dry face, *n.* A face that has ceased to yield crude turpentine. (S. F.)
Syn.: dead face.

Dry-ki, *n.* Trees killed by flooding. (N. F.)

Dry kiln. A structure in which lumber is dried by artificial heat. (Gen.)
Syn.: kiln, lumber kiln.

Dry mill. A sawmill that has no log pond. (Gen.)

Dry pick, to. As applied to a jam, to remove logs singly while the water is cut off. (N. F.)

Dry roll, to. In sacking the rear, to roll stranded logs into the bed of the stream from which the water has been cut off preparatory to flooding. (N. F.)

Dry rot. Decay in timber without apparent moisture. (Gen.)

Dry slide. *See* Slide.

Dry sloop, to. To sloop logs on bare ground when the slope is so steep that it would be dangerous to sloop on snow. (N. F.)

Dublin standard. *See* London standard.

Dudler, *n.* *See* Dudley.

Dudley, *n.* An engine for hauling logs, which propels itself along steel rails and drags its load by revolving a large spool around which are several turns of a cable fixed at each end of the track. (P. C. F.)
Syn.: dudler.

Duffle, *n.* The personal belongings of a woodsman or lumberjack which he takes into the woods. (Gen.)
Syn.: dunnage (N. W.).

Duffle bag. A canvas sack used to carry the clothing and personal belongings of woods workers.
Syn.: dunnage bag.
See Turkey.

Dump, *n.* 1. A term applied to portable mill lumber yards. (New Jersey.)
2. *See* Pit.

Dump hook. A levered chain grab-hook attached to the evener to which a team is hitched in loading logs. A movement of the lever releases the hook from the logging chain without stopping the team. (N. F.)

Dump logs, to. To roll logs over a bluff or from a logging car or sled into the water. (Gen.)

Dunnage, *n.* (Log.) 1. Sawmill refuse, used to ballast logging railroad spurs in a cypress swamp. (S. F.)
Syn.: dust.
2. *See* Duffle.
(Lum.) Lumber of a grade below that recognized in lumber market quotations. Cull lumber, usable for certain purposes. (P. C. F.)

Dunnage bag. *See* Duffle bag.

Dust, *n.* *See* Dunnage.

Dust a dam, to. To fill up with earth or gravel the cracks or small holes between planks in the gate of a splash dam. (N. W.)

Duster, *n.* A dead standing yellow-pine tree with a sound heart. (S. F.)

Dutchman, *n.* A short stick placed transversely between the outer logs of a load to divert the load toward the middle and so keep any logs from falling off. (N. F.)

Dutch oven. An extension front used with boilers burning sawdust and similar fuel. It provides greater fuel space and allows of more complete combustion. (Gen.)

Earth slide. A furrow in the earth in which logs are dragged. This is sometimes iced in winter to facilitate skidding. (App.) *See* Gutter road.

Edge, *v.* To make square-edged. (Gen.)

Edge-grained. (E. G.) *See* Quarter-sawed.

Edger, *n.* A machine used in sawmills to square-edge waney lumber and also to rip lumber. It consists of a frame supporting an arbor on which are mounted several circular saws, feed rolls, press rolls, and transmission gear. (Gen.)

Edger helper. *See* Tripper.

Edgerman, *n.* One who feeds boards into an edger. (Gen.)

Edge sorter. 1. A lumber sorting device consisting of grooves in which the lumber is placed on edge. Lines of live rolls, arranged under the grooves, carry the lumber to the desired point. (Gen.)
2. One who operates an edge sorter.

Edge stacker. A machine which stacks lumber on edge on dry kiln trucks. (Gen.) *See* Stacker.

Edger tables. Tables with live rolls which are placed both in front of and behind the edger. (Gen.)

Edger tailer. In a sawmill, one who removes the strips and edgings from the rolls at the rear of the edger. (Gen.)
Syn.: strip catcher, tail edger.

Edging grinder. *See* Hog.

Edgings, *n.* The waste strips cut from the edge of boards. (Gen.)
Syn.: strips.

Encased knot. A knot surrounded wholly or partially by pitch or bark. (Gen.)

End butt, to. *See* Trim.

End mark. *See* Mark.

End match, *v.* To tongue and groove the ends of matched lumber. (P. C. F.) *See* Dressed and headed.

End-pile, to. To pile lumber on end. A method sometimes employed in storage sheds, both at the manufacturing plant and at the retail yards. (Gen.)

Equalizer, *n.* (Lum.) A machine with two circular saws which is used to trim the ends of lath bundles and stave bolts. (Gen.) *See* Trimmer.
Syn.: equalizing machine.
2. One who operates an equalizer saw in a stave factory. (S. F.)
(Log.) *See* Spreader.

Equalizing machine. *See* Equalizer.

Estimate, *v.* *See* Cruise.

Estimator, *n.* *See* Cruiser.

Evans third saw. A machine having four circular saws formerly used to break down large redwood logs. (P. C. F.)

Excelsior, *n.* Long string-like shavings made from wood and used as a stuffing for mattresses and as a packing material for many articles. (Gen.)

Ex quay. A marine shipping term signifying that the shipper agrees to deliver the goods to the buyer on the quay at bill-of-lading destination with all quay charges, including measurement, rent, master porterage, insurance, watching, and like charges paid, until such time as the buyer takes delivery of the goods according to the custom of the port. (U. K.)

Ex ship. A marine shipping term signifying that the shipper's responsibility continues until the goods are delivered overside at bill-of-lading destination, after which time it ceases. (U. K.)

Extract wood. Wood which is suitable for the manufacture of tannin extract. Chestnut is the principal native extract wood. (N. F.)

Face, *n.* (Lum.) The lower concave portion of a saw tooth. (Gen.)
(Turp.) The cut surface of sapwood from which crude turpentine exudes. (S. F.)

Face count. In surfaced lumber, the measurement of the actual area as contrasted to the measurement of the area of the rough strip from which it was made. (Gen.) *See* Strip count.

Face log. *See* Head log.

Face measure. *See* Surface measure.

Face Side. In grading rough or S 2 S softwood boards, that side which shows the best quality, while on boards S 1 S the surfaced side is the face side. Hardwoods are usually graded from the poorer or face side.

Fairleader. A device consisting of four rollers or sheave wheels arranged in pairs, the axes of each pair being at right angles to each other. It is placed on a support on the front end of a donkey sled and gives the cable a straight lead onto the drum. (P. C. F.)
Syn.: dolly. (P. C. F.)

Faller, *n.* One who fells trees. (Gen.) *See* Head faller; Second faller.
Syn.: chopper (App.), sawyer (Gen.), cutter, flathead (S. F.).

Falling ax. An ax with a long helve and a long narrow bit, designed especially for felling trees. (Gen.)

Falling crew. A crew of two or three fallers. (Cal.)
Syn.: falling set, pair of fallers (P. C. F.).

Falling irons. *See* Falling plates.

Falling plates. Thin, wide plates of iron which are placed above and below falling wedges when the wood is so soft that the wedges cut into it. (P. C. F.)
Syn.: falling irons.

Falling set. *See* Falling crew.

Falling wedge. A wedge used to throw a tree in the desired direction by driving it into the saw kerf. (Gen.)

Fantail, *v.* To lay out radial runs for pullboat logging, each main run having one or more branches. (S. F.)

Farm, *n.* *See* Turpentine orchard.

F. A. S. 1. A shipping term, "free alongside," which denotes that the price includes delivery alongside the vessel without cost to the buyer. (Gen.)
2. An abbreviation used by hardwood lumbermen to designate the combined grade of Firsts and Seconds.

Fast. In saw filing, a saw, when raised up, is said to be "fast" in those places that come up to the straight edge. (Gen.)

Fathom, *n.* An English measure for pit timbers, equivalent to 216 cubic feet.

Fatwood. *See* Lightwood.

Feather-edge. A board which is thinner on one edge than it is on the other is said to have a feather-edge. (Gen.)

Feed, *n.* In sawing lumber, the linear length of log, expressed in inches, which is cut at each revolution of the saw. (Gen.)

Feeder, *n.* *See* Barn boss.

Feed rolls. Live rollers with a smooth, corrugated or rough surface, which are used to feed lumber into an edger, resaw, planer, or other machine. (Gen.) *See* Live rollers.

Felloe. *See* Felly.

Felly, *n.* One of the curved segments of the rim of a wheel between the spokes and the tire. It is sawed to the shape in which it is used. (Gen.) *See* Rim.
Syn.: felloe.

Fence boom. A patent log-towing boom used at one time on the Great Lakes. (E. C.)

Fencing, *n.* A grade of rough 1-inch softwood lumber usually 4 or 6 inches in width. (Gen.)

Fender boom. *See* Shear boom.

Fibre-saturation point. In seasoning wood, that point at which all the free water has been driven off and the cell walls begin to dry. (Gen.)

Fiddle butts. Large spruce butt logs suitable for the manufacture of musical instruments. (N. W.)

Fid hook. A slender, flat hook used to keep another hook from slipping on a chain. (N. W., L. S.)

Figure-grained. *See* Quarter-sawed.

File a saw, to. *See* Fit a saw, to.

Filer, *n.* (Log.) One who files the cross-cut saws in the woods. (Gen.)
Syn.: saw fitter.
(Lum.) One who fits saws in a sawmill or other woodworking plant. (Gen.)

Fin boom. A form of boom used on navigable streams (where permanent booms are not allowed) to direct logs from one side of the stream to the other. By changing the angle between the fins attached on the down-stream face of the boom and the boom itself the latter may be thrown across the stream at any angle less than 90 degrees. (Gen.)
Syn.: rudder boom. (P. C. F.)

Fine grain. Wood is said to have a fine grain when the annual rings of growth are narrow. (Gen.)

Finish, *n.* The higher grades of lumber. (S. F., L. S.)
Syn.: finishing, uppers.

Finishing. *See* Finish.

Firm red heart. Firm heartwood which has a reddish color due to decayed wood adjacent to it. It is an incipient stage of red rot. (S. F.)
Syn.: red heart.

First open water. *See* F. O. W.

Firsts and Seconds. *See* F. A. S.

Fish plate. A narrow bar of steel having from four to six holes through which bolts may be inserted. Two fish plates are used to join steel rails at the joints, one plate being placed against each side of the web and both bolted to it. (Gen.)

Fit, *v.* 1. To notch a tree for falling and after it is felled to mark it into the log lengths into which it is to be cut. (N. F.)
2. To ring, split, and peel tanbark. (N. F.)

Fit a saw, to. To put it into proper condition for sawing. (Gen.)
Syn.: file a saw, to.

Fitter, *n.* 1. One who notches the tree for felling and after it is felled marks the log lengths into which it is to be cut. (N. F.)
2. One who cuts limbs from felled trees and rings and slits the bark preparatory to peeling tanbark. (N. F.)
Syn.: preparer.

Five-ply veneer. A piece of built-up veneer composed of five pieces glued one to the other. *See* Laminated wood.

Flagman, *n.* One who transmits orders from the tonghooker to the steam skidder leverman. (S. F.)

Flat grain (F. G.). *See* Plain-sawed.

Flathead. *See* Faller.

Flitch, *n.* A thick piece of lumber with wane on one or both edges. (Gen.)

Float, *v.* *See* Drive.

Float road. A channel cleared in a swamp and used to float cypress logs from the woods to the boom at the river or mill. (S. F.)
Syn.: creek, driving road.

Flood, *v.* *See* Splash.

Flood dam. *See* Splash dam.

Floorer, *n.* A type of planer and matcher used to manufacture flooring. (P. C. F.) *See* Planer and matcher.

Flume, *n.* A trough in which water runs, used in transporting logs, lumber or timbers. (Gen.)
Syn.: chute (E. C.), sluice, water slide, wet slide.

Flume, *v.* To transport logs, lumber, or timber by a flume. (Gen.)
Syn.: sluice.

Flunky, *n.* 1. An assistant to the cook in a logging camp. (P. C. F.)
2. *See* Cookee; Chore boy.

Flying drive. A drive, the main portion of which is put through with the utmost dispatch without stopping to pick the rear. (N. F.)

Flying machine. *See* Cableway skidder.

Fly road. *See* Tote road.

Fly rollway. A skidway or landing on a steep slope from which the logs are released at once by removing the brace which holds them. (N. F.)

F. O. B. A shipping term, "free on board," which denotes that the price quoted includes loading on the car or vessel. (Gen.)

F. O. B. Cars, — cent rate. A trade term signifying that the price quoted includes the f. o. b. mill price plus a specified number of cents per 100 pounds freight charge on the net weight of the lumber. The shipper thereby limits his liability for freight charges. (Gen.)

F. O. R. A shipping term, "free on railway." (U. K.)

Fore-and-aft road. A skid road made of logs placed parallel to its direction, making the road resemble a chute. (P. C. F.)
Syn.: pole chute, stringer road.

F. O. T. A shipping term, "free on trucks," usually railway trucks. (U. K.)

Four paws. *See* Double couplers.

F. O. W. A marine shipping term, "first open water," referring to shipments through ports which, during certain periods of the year, are closed by ice. Contracts made f. o. w. while the port is closed are for shipment as soon as the water is sufficiently free from ice to permit the resumption of boat service. (U. K.)

Free on board. *See* F. O. B.

Friction nigger. A long-toothed lever arm actuated by a friction device which is used to turn logs on a sawmill carriage. (Gen.) *See* Steam nigger.

Free alongside. *See* F. A. S.

Free on railway. *See* F. O. R.

Free on trucks. *See* F. O. T.

Froe, *n.* 1. A steel blade, 6 or 7 inches long, with a wooden handle at right angles to the blade. It is used to rive shakes and split staves from bolts. (Gen.)
2. An iron wedge used in splitting logs. (Gen.)
3. A contemptuous term applied to a dull ax. (App.)

Frog, *n.* 1. The junction of two branches of a flume. (P. C. F.)
2. The junction of two branches of a chute; also any place where an opening is made in a chute to permit the yarding of logs into it. (Cal.)
3. A timber placed at the mouth of a slide to direct the discharge of the logs. (Gen.)
Syn.: throw out.

Frogger, *n.* *See* Sled tender.

Frog shoveler. A member of a chute crew or a yarding crew who cleans out dirt and bark at frogs. (Cal.)

Front, *n.* The point at which logging on a particular operation is being conducted. (Texas.)

Full scale. Measurement of logs in which no reduction is made for defects. (Gen.)
Syn.: bigness scale. (N. F.)

Furnace kiln. A kiln heated by means of large drums which receive their heat from furnaces located under the kiln. (Gen.)

Furring. A narrow strip of 1-inch lumber which is nailed to rafters, studding, and joists as a backing for lath. (Gen.)

Gaff, *n.* The steel point of a pike pole, consisting of a screw point and a spur. (Gen.)

Gang edger. An edger that has fixed saws. (Gen.)

Gang mill. A lumber sawing machine with a heavy frame supporting a sash which carries straight saw blades. The sash works in vertical slides and is driven by a pitman from below. (Gen.)

Gang saw. A ribbon of steel from 6 to 10 inches wide and from 44 to 48 inches long, which is toothed on one edge. A number of these saws are stretched in the sash of a gang sawmill. They cut only on the downward stroke. (Gen.)
See Mulay saw; Sash saw.

Gang sawyer. One who has charge of the mechanism of the gang saw. He also controls the rate of speed at which logs are sawed. (Gen.)

Gang tailer. In a sawmill, one who takes care of the lumber as it comes from the gang saw. (Gen.)

Gangway. *See* Log haul-up.

Gap stick. A pole placed across the entrance of a sorting jack to close it, when not in use. (Gen.)

Gate saw. *See* Sash saw.

Gauge, *n.* 1. The thickness of a saw blade. In the United States it is measured according to the Stubbs wire gauge. (Gen.)
2. A scale for measuring the thickness of a saw blade. (Gen.)
3. *See* Set works scale.

Gee throw. A heavy, wooden lever, with a curved iron point, used to break out logging sleds. (N. F.)
Syn.: starting bar.

Georgia pine. A trade name for southern yellow-pine timber from the Atlantic coast region. (Gen.)

German siding. *See* Drop siding.

Gig a carriage, to. Reversing the run of a sawmill carriage after a board has been cut from the log. (Gen.)

Gill-poke. A swinging-arm type of log car unloader. (P. C. F.)

Gin pole. A pole secured by guy ropes, to the top of which tackle for loading logs is fastened. (Gen.)

Glancer, *n.* *See* Tender skid.

Glancing boom. *See* Shear boom.

Glisse skids. Freshly peeled skids up which logs are slid instead of rolled when being loaded. (N. F.)
Syn.: slip skids.

Glut, *n.* A wooden wedge used in tie making. (S. F.)

Go-back road. A road upon which unloaded logging sleds can return to the skidways for reloading without meeting the loaded sleds en route to the landing. (N. F.)
Syn.: short road.

Go-devil. A small sled, without a tongue, often made from the natural fork of a tree and used as an aid in skidding logs on stony or bare ground. (L. S., N. F.)
Syn.: alligator, crazy dray (S. F.), crotch, travois (L. S., N. F.)

Gobb, *n.* *See* Sticker.

Gooseneck, *n.* 1. A wooden bar used to couple two logging trucks. (Gen.)
Syn.: rooster (P. C. F.)
2. The point of draft on a logging sled; it consists of a curved iron hook bolted to the roll. (N. F.)
Syn.: draw hook.
3. A V-shaped pair of thills joining the forward and rear sets of runners of a logging sled. (N. W.)
4. A curved iron driven into the bottom of a slide to check the speed of descending logs. (App., R. M. F.)
Syn.: scotch, sprag. (App.)
5. *See* Yoke.

Goosepen. A large hole burned in a standing tree. (P. C. F.)

Gopher, *n.* 1. One who makes a hole under a load of logs so that the chains on a pair of logging wheels can be placed around it. (Cal.)
2. In power logging, one who digs holes under the log so that a choker can be adjusted on it. (Cal.)
Syn.: choker-hole digger, swamper.

Grab-driver. One who attaches coupling grabs to a turn of logs. (App.)

Grab hook. A hook having a narrow throat, adapted to grasp any link of a chain. (Gen.)

Grab link. *See* Slip grab.

Grabs, *n.* *See* Skidding tongs.

Grab setter. One who attaches the grabs when logs are transported on logging wheels. (S. F.)

Grab skipper. A short iron pry or hammer, used to remove the skidding tongs from a log. (App., S. F.)

Grade, *n.* A term referring to the quality of lumber. (Gen.)

Grade, *v.* To assort lumber and classify it according to quality. (Gen.)
Syn.: cull (E. C.), inspect, survey (N. F.).

Grader, *n.* One who inspects and classifies lumber according to the defects present. (Gen.)
Syn.: culler (E. C.), scaler, inspector.

Grading rules. Specifications by which lumber is grouped according to quality (Gen.)

Grain, *n.* In wood, a term used with reference to the arrangement or direction of the wood elements and to the relative width of the growth rings. To have a specific meaning it must be qualified. (Gen.)

Grapples, *n.* 1. Two small iron dogs joined by a short chain and used to couple logs end to end when skidding on mountains, so that several logs may be skidded by one horse at the same time. (N. F.)
Syn.: chain grapples, coupling grab (P. C. F.), trail dogs (R. M. F.).
2. *See* Skidding tongs.

Grass line. *See* Straw line.

Gravel a dam, to. To cover with gravel or earth the up-stream side of the timber work of a dam to make it water tight. (N. F.)

Greaser, *n.* 1. One who applies skid grease to a chute. (P. C. F., R. M. F.)
Syn.: chute greaser, skid greaser.
2. *See* Chore boy.

Green lumber (G.). Lumber, the moisture content of which is greater than air-dried lumber. Unseasoned. (Gen.)

Green planer. A planing mill in which green lumber is surfaced. (Gen.)

Grips, *n.* *See* Skidding tongs.

Grooving saw. A small circular saw of special pattern adapted for cutting a groove in a board. (Gen.) *See* Dado-head saw.

Gross hundred. As referring to European lumber measurement, 120 pieces which comprise a standard hundred.

Ground hog. *See* Ground skidder.

Ground loader. That member of a loading crew who attaches the tongs or loading hooks to the log, or who guides the logs up the skids. (Gen.)
Syn.: bottom loader, hooker, hooker-on, send-up man (Gen.), hookman, tong puller (S. F.), tong hooker (App.), sender (E. C.).

Ground skidder. A power skidder which skids logs on the ground. (Gen.)
Syn.: ground hog. (App.)

Grouser, *n.* A large and long stick of squared timber sharpened at the lower end and placed in the bow of a steam logging boat; it takes the place of an anchor in shallow water, and can be raised or lowered by steam power. (N. W., L. S.)

Guard a hill, to. To keep a logging road on a steep incline in condition for use. (N. F.)

Gullet. *See* Throat.

Gum, *n.* *See* Crude turpentine.

Gum, *v.* To grind out the throats of a saw. (Gen.)
Syn.: chamber.

Gummer, *n.* A tool used to cut out the throats of a saw. (Gen.)
Syn.: chambering machine.

Gun, *n.* A device which is inserted into an undercut to determine the direction of fall of the tree. (P. C. F.)
Syn.: gunning stick, shot-gun, timber compass.

Gun, *v.* 1. To aim a tree in felling it. In case of very large, brittle trees, such as redwood, a sighting device is used. (Cal.)
Syn.: point, swing.
2. *See* Cannon a log, to.

Gun a log, to. *See* Cannon a log, to.

Gun boat. *See* Catamaran.

Gunning stick. *See* Gun.

Gutter, *n.* A narrow zinc or galvanized-iron strip bent V-shaped which furnishes a channel for guiding crude turpentine into a cup. (S. F.)

Gutterman. *See* Swamper.

Gutter road. The path followed in skidding logs. (Gen.)
Syn.: drag road, earth slide, runway, skidding trail, snaking trail.

Guy line. 1. Lines used to hold raft timbers together. (N. W.)
2. Lines which support a gin pole, spar, or tail trees. (Gen.)

Gypsy yarder. *See* Spool donkey.

Hack, *n.* (Turp.) A strong gouge-shaped knife with a curved edge fastened to the end of a short handle, bearing on its lower end an iron ball weighing about 4 pounds. It is used to chip timber. (S. F.) *See* Puller.
Syn.: hacker.

Hack, *v.* (Log.) To hew. Usually applied only to the hewing of cross-ties. (Gen.)
(Turp.) *See* Chip.

Hacker, *n.* *See* Hack.

Half-breed, *n.* A donkey engine designed for long distance yarding or for use as a roader on short distance hauling. (P. C. F.) *See* Yarding donkey.
Syn.: donkey.

Half-moon tie. A tie made from a stick of timber yielding two ties. (S. F.)

Hammer a saw, to. To pound it with a special type of hammer in order to adjust the tension. (Gen.)

Hand-bag. *See* Hand-bank.

Hand-bank, *v.* To haul to the banking ground, with hand sleds, ties or other timbers that are to be floated. (R. M. F.)
Syn.: hand-bag.

Hand-banker. One who hauls ties on a hand sled from the stump to the landing. (R. M. F.)

Handbarrow. Two strong, light poles held in position by rungs, upon which bark or wood is carried by two men. (N. W., L. S.)
Syn.: ranking bar.

Hand dog. *See* Dogwarp.

Hand grab. *See* Dogwarp.

Hand log, to. To move timber without the aid of animal or mechanical draft. (Gen.)

Hand logger. Formerly one who logged without the use of animals or power. The term is now sometimes applied to loggers in the Northwest who use animals instead of power skidders. (P. C. F., R. M. F., S. F.)

Hand-made shingle. *See* Shake.

Hand pike. A piked lever, usually from 6 to 8 feet long, for handling floating logs. (Gen.)
Syn.: pike lever. (N. W.)

Hand planer. A hand-feed surfacing machine with a single cutter head. (Gen.)
Syn.: jointer.

Hand skid, to. To move timber by hand to a point where it can be reached by horse or other form of transport. (R. M. F.)

Hand skidder. One who accompanies a log as it is being dragged and places short skids beneath it. (P. C. F.)

Hand sluice, to. To shoot logs down steep slopes on a crude slide made by felling timber down the slope, cutting off the top and arranging the boles so that a rough trough results. Snow greatly facilitates hand sluicing. (E. C.)

Hang an ax, to. *v.* To fit a handle to an ax. (Gen.)

Hang a saw, to. In a sawmill, to place a saw in position ready for operation. (Gen.)

Hang the boom, to. To put the boom in place. (Gen.)

Hang up, to. 1. To fell a tree so that it catches against another instead of falling to the ground. (Gen.)
Syn.: lodge (Gen.), buckwheat (App.).
2. In hauling with a team, to get the load stuck either in the mud or behind a stump.
3. As applied to river driving, to discontinue; thus a drive may be "hung up" for lack of water or for some other reason.

Hardwood, *a.* As applied to trees and logs, broadleaved, belonging to the dicotyledons. (Gen.)
Syn.: broadleaf.

Hardwood, *a.* (Lum.) As applied to lumber, that which is cut from dicotyledons. (Gen.)

Hardwood, *n.* (Log.) A broadleaved, or dicotyledonous, tree. (Gen.)

Haul, *n.* In logging, the distance and route over which teams must go between two given points, as between the yard or skidway and the landing. (Gen.)

Haul back. A small wire rope, traveling between the power skidder and a pulley set near the logs to be dragged, used to return the main cable with tongs, chokers, or hooks to the next log. (P. C. F., R. M. F., S. F.)
Syn.: back line, messenger, pull back, return line, trip line.

Haul back block. The block used on the haul back line. (P. C. F.)

Haul up. A light chain and hook by which a horse may be hitched to a cable in order to move it where desired. (P. C. F.)

Hay road. *See* Tote road.

Hay wire outfit. A contemptuous term for a poor logging outfit. (N. F.)

Head block. (Lum.) That portion of the sawmill carriage on which the log directly rests and also that part which holds the log. Each head block consists of a base, a knee, a taper set, dogs, and a rack and pinion gear, or some similar device for advancing the knees toward or withdrawing them from the saw line. (Gen.)
(Log.) The log placed under the front end of the skids in a skidway to raise them to the desired height. (N. F.)

Head bucker. *See* Saw boss.

Head chopper. The foreman of a yarding crew. (N. W.)

Head driver. An expert river driver who, during the drive, is stationed at a point where a jam is feared. Head drivers usually work in pairs. (N. F.)
Syn.: log watch (N. F.), jam cracker (P. C. F.)

Head-end dogger. *See* Dogger.

Head faller. The chief of a crew of fallers. (P. C. F., R. M. F.) *See* Second faller.

Head grabs. The grabs, on the first log of a turn, to which the draft power is attached. (App.) *See* Skidding tongs.

Head hooker. The chief of a pullboat skidding crew. (S. F.)

Heading, *n.* The pieces of lumber from which a keg or barrel head is cut. (Gen.)

Heading chipper. A machine for dressing heading to any thickness. (Gen.)

Heading rounder. A machine for rounding heading. (Gen.)
Syn.: heading shaper.

Heading shaper. *See* Heading rounder.

Head loader. When two men are engaged in loading logs on trucks or cars, one is termed head loader and the other second loader. (P. C. F., R. M. F.) *See* Top loader.

Head log. 1. The front bottom log on a skidway. (N. F.)
Syn.: face log.
2. The front log in a turn. (P. C. F.)
Syn.: lead log.

Head push. *See* Straw boss.

Headquarters, *n.* In logging, the distributing point for supplies, equipment, and mail; usually not the executive or administrative center. (Gen.) *See* Cache.

Head saw. The log-cutting saw in a sawmill. (Gen.)
Syn.: log saw.

Head sawyer. *See* Sawyer.

Head-spar tree. In steam skidding, the tree near the railroad to which one end of the cable upon which the trolley runs is attached. (Gen.)
Syn.: head tree, spar tree.

Head tree. *See* Head-spar tree.

Headworks, *n.* A platform or raft, with windlass or capstan, which is attached to the front of a log raft or boom of logs for warping, kedging, or winding it through lakes and still water, by hand or horse power. (N. W., L. S.)
Syn.: crab. (N. F., S. F.)

Heavy joists. In southern yellow pine, 2-inch stock, 14 inches wide, and also 2½-inch and 3-inch stock which ranges, by even inches, from 10 to 14 inches wide.

Hedgehog, *n.* A set of cone-shaped live rollers with a spiked or roughened surface. It is used in dry-land shingle mills for bringing the logs to the drag saw, being substituted for a log jack and a jacker chain. (P. C. F.)

Hell. *See* Refuse burner.

Helper, *n.* *See* Second faller.

Herder, *n.* One who patrols a lumber or log flume to prevent jams. (Cal.)

High face. *See* Pulling face.

High-lead logging. A modification of donkey yarding, the main cable rigging at the railroad being suspended on a head-spar similar to that used in cableway logging. (P. C. F.)

Hog, *n.* A machine used for cutting wood into chips. Often used to convert sawmill and planing mill refuse into fuel; also to reduce pulpwood to chips. (Gen.)
Syn.: chipper (E. C.), edging grinder, refuse grinder.

Hoist, *n.* (Log.) *See* Incline; Loading tripod.
(Lum.) *See* Log haul-up.

Hold, *n.* The attachment of tackle to a log or other object to be moved. (P. C. F.)

Holder. *See* Shank.

Holding boom. *See* Storage boom.

Hollow-backed (H. Bk.). A board is said to be hollow-backed when a small amount of wood has been removed from the central part of the back side in order to reduce its shipping weight. (Gen.)

Hollow-horned. *See* Honey-combed.

Honey-combed, *a.* Lumber is said to be in a honey-combed condition when numerous large season cracks are present on the surface. (Gen.)
Syn.: hollow-horned.

Hook, *n.* The angle between the face of a tooth and a line drawn from the extreme point of the tooth perpendicular to the back of a band saw, or to the center of a circular saw. Hook is stated in terms of inches. On a band saw it is measured between the two lines prolonged to its back; on a circular saw it is measured along the opposite side of the triangle.

Hookaroon, *n.* A recurved pike, or a pike and a hook fitted to a handle from 36 to 38 inches long. Used in handling cross-ties, lumber, poles, posts, staves, timber, and like products. (Gen.)
Syn.: pickaroon.

Hooker, *n.* 1. One who works with a teamster in bunching logs. (Cal.)
2. *See* Ground loader.
3. *See* Hook tender.

Hooker-on. *See* Ground loader.

Hook man. 1. One who works with a cant hook or peavey. (L. S., R. M. F.)
2. *See* Ground loader.

Hook tender. The foreman of a yarding crew; specifically, one who directs the attaching of the cable to a turn of logs. (P. C. F.)
Syn.: hooker (P. C. F.), logger (Cal.), yarding hook tender (R. M. F.).

Hoppus String Measure. A method of measuring the cubic contents of logs and other round timber. The formula for determining the cubic contents is—

$$\left(\frac{G}{4}\right)^2 \times \frac{L}{144} = C,$$

in which G equals the girth in inches, L the length of log in feet, and C equals the cubic contents. In practice the girth is taken at center of log, inside of bark, by means of a string, the quarter girth then being found by doubling the string (girth length) twice and measuring to the nearest quarter-inch. The length (L) is measured to the nearest one-half foot. Contents are determined to the nearest one-half cubic foot. When the girth measurement can not be taken inside of bark an allowance is made for bark thickness.

In theory the Hoppus String Measure reduces a round log to its square equivalent. (U. K.) *See* Caliper measure; Liverpool String Measure.

Horizonal band resaw. A band resaw which cuts in a horizontal line, as compared to a vertical band resaw which cuts in a vertical line. (Gen.)

Horn knot. *See* Spike knot.

Horse bucker. A stave bucker operated by a sweep horse power. (S. F.)

Horse dam. Temporary dam made by placing large logs across a stream, in order to raise the water behind it, so as to float the rear. (N. F.)

Horse logs, to. In river driving, to drag stranded logs back to the stream by the use of peaveys. (N. F.)

Hot logging. A logging operation in which logs go forward from stump to mill without pause. (Gen.)

Hot skidway. A skidway from which logs are immediately loaded. (N. W.)

Hovel, *n.* A stable for logging teams. (N. W., L. S.)

Husk, *n.* The frame supporting the arbor and other working parts of a large circular saw. (Gen.)

Ice a road, to. To sprinkle water on a logging road so that a coating of ice may form, thus facilitating the hauling of logs. (N. F.)

Ice box. *See* Sprinkler.

Ice guards. Heavy timbers fastened fan-shaped about a cluster of boom piles at an angle of approximately 30 degrees to the surface of the water. They prevent the destruction of the boom by ice, through forcing it to mount the guards and be broken. (N. F.)

Incinerator. *See* Refuse burner.

Incline, *n.* A portion of a logging railroad, the grade of which is too steep for the operation of locomotives, and up or down which the log cars are raised or lowered by means of a cable and power. When logs are hauled up grade the incline is sometimes called a hoist. (Gen.)

Inserted-tooth, *n.* *See* Bit.

Inserted-tooth circular saw. A circular saw on whose periphery are sockets in which removable shanks and bits are inserted. (Gen.)

Inspect. *See* Grade.

Inspector. *See* Grader.

Interior trim. Lumber used for finishing the interior of buildings. (Gen.)
Syn.: trim.

Irish standard. *See* London standard.

Irish standard hundred. *See* London standard.

Jack, *n.* **1.** A type of jack screw sometimes used for rolling logs off from the right of way, where railroad grading is being done by hand. The jack screw was formerly used to shift logs on a landing where cars were being loaded by hand. (P. C. F.)

2. In aerial logging, a shoe which rests on a guy line and supports the loading block. (P. C. F.)

Jack, *v.* In lumber piling, to pass up boards to the piler on top of the lumber stack. (Gen.)

Jack chain. An endless spiked chain which moves logs from one point to another, usually from the mill pond into the sawmill. (Gen.)
Syn.: jacker chain (Gen.), bull chain, log haul chain (P. C. F.).

Jacker. *See* Pond man.

Jacker chain. *See* Jack chain.

Jackerman. *See* Pond man.

Jack ladder. *See* Log haul-up.

Jackpot, *n.* 1. A contemptuous expression applied to an unskillful piece of work in logging. (N. F.)
2. An irregular pile of logs. (App.)
3. A bad slash. (N. W.)
4. Lodgment of one or more trees in another in felling.
Syn.: siwash. (P. C. F.)

Jack slip, *n.* *See* Log haul-up.

Jack works. (Log.) *See* Loading jack.
(Lum.) *See* Log jack.

Jam, *n.* A stoppage or congestion of logs in a stream, due to an obstruction or to low water. (Gen.)

Jam, *v.* To form an obstruction of logs in a stream. (N. F., E. C.)

Jam cracker. *See* Head driver.

Jam hook. *See* Swamp hook.

Jam, to break a. To start in motion logs which have jammed. (Gen.)

Jammer, *n.* 1. An improved form of gin, mounted on a movable framework, and used to load logs on sleds and cars by horse-power. (N. F.)
2. A power log loader, usually of the McGiffert type. (Cal.)

Jay hawk, to. To strip only one 4-foot length of bark from a tanbark oak, leaving the tree standing. (P. C. F., N. W.)

Jay hole. On steep skidding roads, a place of refuge for the team when the turn of logs has attained high speed. (App.)

J-hook, *n.* A hook, with a recurved head, to each end of which a grab is attached by a short chain. The J-hook is fastened to the top of the forward log of a turn on a skipper road and serves as the point of attachment for the draft. If the logs start to run, the draft animals can be automatically freed by turning them at right angles to the road. (App.)

Jiboo, *v.* To remove a dog from a log. (N. W., L. S.)

Jig, *v.* *See* Jigger.

Jigger, *v.* To pull a log by horse-power over a level place in a slide. (Gen.)
Syn.: jig, lazy haul, to (Gen.), trail (R. M. F.)

Jig team. A team of horses used to jigger logs. (App.)

Jim binder. *See* Binder.

Jim crow. A type of rail bender used for bending or straightening steel rails. (Gen.)

Jim crow loads. A logging car or truck loaded with a log so large that one constitutes a load. (P. C. F.)

Jobber, *n.* A logging contractor or subcontractor. (Gen.)

Jobber's sun. A term applied to the moon in a jobber's or contractor's logging camp, on account of the early and late hours of commencing and ending work. (N. W., L. S.)

Joiner. *See* Matcher.

Joint, *n.* A section of a raft. (E. C.)

Joint, *v.* To make staves square-edged, and to give them the proper taper at the ends. (Gen.)

Jointed flooring. A flooring strip that has been surfaced and the sides of which, instead of being tongued and grooved, are cut on a slight bevel. Used chiefly in New England for porch floors; sometimes for ship decking.

Jointer, *n.* (Log.) 1. In cross-cut saw fitting, a tool which is placed over the ends of the teeth and which serves as a guide for the file when the teeth are being reduced to a uniform length. (Gen.)
(Lum.) 1. *See* Lister.
2. *See* Hand planer.
3. *See* Knot saw.

Jointer wheel. *See* Lister.

Joist, *n.* 1. A piece of dimension or a timber which is used to support the floor of a building. (Gen.)
2. A piece of lumber 8 feet or more in length, from 1½ to 4½ inches in thickness, and from 6 to 12 inches wide. (English markets.)

Juggler. *See* Log roller.

Jumbo, *n.* 1. A type of tongueless double sled used for short-distance hauling. (L. S.)
Syn.: double dray.
2. *See* Bull block.

Jumper, *n.* (Log.) A sled made wholly of wood, used for hauling supplies over bare ground into a logging camp. (N. F., E. C.)
See Mudboat; Whip-poor-will.
Syn.: tote sled.
(Lum.) *See* Swage.

Jump saw. A circular saw, the base of whose frame is attached to the piston of a steam cylinder, to an eccentric, or to a shaft, so that the saw frame can be raised or lowered in a vertical line. The saw is placed below a line of live rolls and is used to cross-cut long boards and timbers, the operator elevating the saw between the live rolls for this purpose. (Gen.)

Katydid, *n.* *See* Logging wheels.

Kedge. *See* Warp.

Key log. In river driving, a log which is so caught or wedged that a jam is formed and held. (Gen.)

Kilhig, *n.* A short, stout pole used as a lever or brace to direct the fall of a tree. (N. W.)
Syn.: sampson.

Kiln. *See* Dry kiln.

Kiln-dried saps. An export grade of southern yellow-pine lumber. (S. F.)

Kiln-dried lumber (K. D.). Lumber which has been seasoned in a dry kiln and contains less moisture than air-dried lumber. (Gen.)

Kiln-dried sidings. *See* Kiln-dried saps.

King swamper. A head swamper. (S. F., App.)
Syn.: buck swamper.

Knee, *n.* That portion of a sawmill carriage head block that bears the carriage dogs which hold the log while being sawed. It also supports the levers used to operate both the carriage dogs and the taper set. (Gen.)

Knee bolter. A machine comprising a circular saw and a small traveling carriage operated by the knee which is used for squaring up shingle bolts and for cutting out defects. (Gen.) *See* Bolter.
Syn.: sapper (P. C. F.)

Knocked-down, *a.* As applied to a box, the various parts previous to their assembling. (Gen.)

Knot, *v.* *See* Limb.

Knot bumper. *See* Limber.

Knot saw. A small circular saw used to cut defects from shingles. (Gen.)
Syn.: jointer, shingle jointer.

Knot sawyer. One who operates a knot saw. (Gen.)

Knotter, *n.* *See* Limber.

Lagging, *n.* Small round or split poles, slabs, rough lumber, or brush placed above the caps and along the sides of mining props. (Gen.)

Lagging poles. Saplings and small timbers which are placed above the caps and along the sides of a set of mining timbers to prevent loose rock from falling into the passageway. (Gen.)

Laker, *n.* A log driver expert at handling logs on lakes. (N. F.)

Laminated wood. A board built up of several thin pieces of wood glued together. *See* Five-ply veneer; Three-ply veneer.
Syn.: compound wood.

Landing, *n.* 1. A place to which logs are hauled or skidded preparatory to transportation by water or rail. A rough-and-tumble landing is one in which no attempt is made to pile the logs regularly. (Gen.)
Syn.: bank, banking ground, brow, log dump, rollway, yard.
2. A platform, usually at the foot of a skid road, where logs are collected and loaded on cars. A lightning landing is one having such an incline that the logs may roll upon the cars without assistance. (Gen.)
3. A cribwork of logs, constituting a platform alongside the railroad track, onto which logs are hauled by a donkey, ready for loading onto cars or trucks (P. C. F.)
Syn.: rollway.

Landing crew. A crew that constructs landings. (P. C. F.)

Landing man. One who unloads logging sleds at the landing. (N. F.)

Landing, to break a. To roll a pile of logs from a landing or bank into the water. (Gen.)

Land looker. *See* Cruiser.

Landscape, *a.* *See* Bird's-eye.

Lap, *n.* Tops left in the woods in logging. (Gen.)
Syn.: lapwood.

Lap, *v.* In hoop making, to reduce the thickness of the pointed end of a hoop so that it will lap over the opposite end. (Gen.)

Lapping machine. A machine for lapping the ends of hoops. (Gen.)

Lap siding. Square-edged boards used to cover the sides of buildings, the lower edge of one board being lapped over the upper edge of the board below. In widths of 6 inches or less the edge is usually beveled, while in greater widths it is not. (Gen.) *See* Bevel siding; Clapboard.

Lapwood, *n.* *See* Lap.

Large knot. A knot that is of any diameter greater than 1½ inches. (S. F., P. C. F.)

Lash pole. A cross pole which holds logs together in a raft. (Gen.)

Lath, *n.* A thin, narrow strip of wood nailed to the wall and ceiling, as a backing for plaster. (Gen.)

Lath binder. A frame in which laths are placed and the bundle compressed so that it can be tied tightly. (Gen.)

Lath bolt. A piece of wood from which laths are manufactured. (Gen.)

Lath bolter. 1. A machine having a number of small circular saws which are used to reduce slabs and other material to the proper thickness for lath manufacture. (Gen.)
2. One who operates a lath bolter. (Gen.)

Lath bundler. One who ties laths into bundles. (Gen.)
Syn.: tie man.

Lath mill. 1. A mill in which laths are manufactured.
2. A machine having several small circular saws which cut bolted lath material into laths. (Gen.)

Lath mill shover. One who feeds lath bolts into a lath mill. (Gen.)

Lazy haul, to. *See* Jigger.

Lead, *n.* A block or roller attached to a stationary object which guides the pull of a cable. (P. C. F.)

Lead block. *See* Bull block.

Lead chains. *See* Cross chains.

Leaders, *n.* In an ox or horse team, the forward pair. (Gen.)

Lead log. *See* Brow skid; Head log.

Lead strap. A wire rope, with an eye at each end, used to anchor the block in setting a lead. (P. C. F.)

Left-hand sawmill. A sawmill in which, when standing on the log deck and facing the rear of the mill, the carriage and saw are on the left hand. (Gen.) *See* Right-hand sawmill.

L-hook, *n.* An L-shaped hook with a long cable, chain, or rope attached. The hook is fastened to the rear of a turn of logs in the trailing portion of a slide and the draft animals to the cable. When the turn starts to run on a steep portion of the slide the hook is automatically released and prevents the logs from dragging the draft animals. (App.)

Lift gate. In a logging dam sluiceway, a gate which may be moved up or down in vertical slides or grooves, fastened to the sides of the sluiceway. (Gen.)

Lightning landing. *See* Landing, 2.

Lightwood, *n.* (Turp.) Pine wood which is heavily impregnated with a resinous substance. (S. F.)
Syn.: fatwood.

Limb, *v.* To remove the limbs from a felled tree.
Syn.: knot. (P. C. F.)

Limber, *n.* One who cuts the limbs from felled trees. (Gen.)
Syn.: knot bumper (App.), knotter (P. C. F., R. M. F.).

Limber boom. A flexible boom, the sticks of which are usually joined to each other by means of short chains or short pieces of manila rope or wire cable. (Gen.)

Lineman, *n.* One in charge of hauling logs in a chute. (P. C. F.)

Line horse. 1. The horse which drags the cable from the yarding engine or skidder to the log to which the cable is to be attached. (S. F.)
2. A horse used to aid the rigging crew in changing lines. Formerly the animal used to haul out the cable from the yarding engine to the log. (P. C. F.)

Lister, *n.* 1. One who operates a lister wheel. (S. F.)
Syn.: jointer.
2. A machine used to square-edge staves and also to give them the proper taper at each end. (S. F.)
Syn.: jointer wheel, wheel jointer.

Live rollers. Power-driven rollers used in a sawmill to transport timbers, boards, and slabs. (Gen.) *See* Dead rollers; Dead rolls.

Liverpool String Measure. A method of measuring the cubic contents of logs and other round timber. The formula for determining the cubic contents is—

$$\left(\frac{G}{4}\right)^2 \times \frac{L}{144} = C,$$

in which G equals the girth in inches and L the length of log in feet and C the cubic contents. The girth measurement is taken by means of a string, at the center of the log, outside of bark, with a standard allowance for the thickness of the latter. The quarter girth is then found by doubling the string (girth length) twice and taking the quarter measurement to the nearest one-half inch. The length (L) is taken to the nearest foot, and the cubic contents to the nearest half-foot. Allowance is made for defects. On an average shipment the Liverpool String Measure gives results about 5 per cent below the Hoppus String Measure. (U. K.) *See* Caliper Measure; Hoppus String Measure.

Lizard, *n.* A crude sled made from the crotch of a tree, used in skidding logs in muddy places. The forward end of the log rests on the sled. (S. F.) *See* Dray.

Load. In European lumber markets, the equivalent of 1680 pounds weight, 50 cubic feet cargo space, or 600 superficial feet of 1-inch thickness.

Loader, *n.* (Log.) One who loads logs on sleds or cars. (Gen.)
Syn.: loaderman. (Gen.)
2. *See* Steam loader.
(Lum.) 1. At a sawmill plant, one who loads lumber on a car. (Gen.)
2. *See* Dock man.

Loader leverman. One who operates the levers controlling the drums on a power loading device. (S. F.)

Loaderman. *See* Loader.

Loading chain. A long chain used in loading or piling logs with horses. (N. F.)
Syn.: docking chain, loading line, rolling chain.
See Crotch chain.

Loading dock. *See* Loading jack.

Loading jack. A platformed framework upon which logs are hoisted from the water for loading upon cars. (N. F.)
Syn.: jack works (N. F.), loading dock (L. S.).

Loading line. 1. The cable on a power skidding device used for loading logs on cars. (Gen.)
2. *See* Loading chain.

Loading tripod. Three timbers joined at their tops in the shape of a tripod, for holding a pulley block in proper position to load logs on cars from a lake or stream. (L. S.)
Syn.: hoist.

Lobby, *n.* In a logging camp, a room in which the men wash and wait for mealtime. Generally found in two-storied camps which have the sleeping quarters on the second floor. (App.)

Lobby hog. *See* Chore boy.

Lock down. A strip of tough wood, with holes in the ends, which is laid across a raft of logs. Rafting pins are driven through the holes into the logs, thus holding the raft together. (N. F.)

Lodge, to. *See* Hang up, to.

Logan, *n.* *See* Pokelogan.

Log boat. A short, tongueless sled with wood runners, used to haul logs to a portable mill operation. (N. F.)

Log bracket. *See* Log dog.

Log chair. *See* Log dog.

Log chute. 1. A trough made of timbers and used for sliding logs down hill, either dry or by aid of water. (E. C.)

Log deck. (Log.) The platform upon a loading jack. (Gen.)
Syn.: deck.
(Lum.) 1. The platform in a sawmill upon which logs are collected and stored previous to placing them on the carriage for sawing. (Gen.)
Syn.: deck, mill deck.
2. *See* Rollway.

Log dog. 1. A metal plate with spuds which is attached to an endless chain used in elevating logs into a sawmill. The spuds catch on the log and enable the chain to carry them up the inclined trough to the mill deck.

Syn.: log bracket, log chair, log saddle, log shoe, log spur.

2. Powerful jaws, operated by a steam cylinder underneath the floor, which are placed in the log trough on the sawmill deck and are used to hold a log while being cross-cut into shorter lengths. One type is operated from overhead.

Syn.: dogging jaws (P. C. F.), log saddle, log seat.

Log dump. (Log.) *See* Landing.

(Lum.) *See* Rollway.

Log fixer. *See* Rosser.

Log flipper. *See* Log kicker.

Logger, *n.* 1. One engaged in logging.

Syn.: lumber jack.

2. *See* Hook tender.

Logging sled. The heavy double sled used to haul logs from the skidway or yard to the landing. (N. F.)

Syn.: sleigh, twin sled, two sled wagon sled.

Logging-sled road. A road leading from the skidway to the landing. (N. F.)

Logging truck. A four-wheeled logging railroad truck with a bunk on which is carried one end of a load of logs. The opposite ends of the logs are supported on a similar truck, a gooseneck often being omitted. (P. C. F.)

Syn.: truck.

Logging wheels. A pair of wheels from 7 to 12 feet in diameter, for transporting logs. (Gen.)

Syn.: katydid, slip-tongue cart, sulky, timber wheels (Gen.), big wheels (Cal.).

Log haul chain. *See* Jack chain.

Log hauler. A steam or gasoline power engine with a special traction device which is used in place of horses to haul logging sleds. (N. F.)

Syn.: caterpillar. (E. C.)

Log haul. *See* Log haul-up; Log jack.

Log haul-up. An inclined plane with a trough up which logs are drawn into a sawmill. (Gen.)

Syn.: gangway, hoist, jack ladder, jack slip, log chute, log jack, log slip, log way, slip (Gen.), log haul (E. C.), log hoist (Cal.).

Log hoist. *See* Log haul-up; Log jack.

Log jack. 1. The gearing in the sawmill driving the endless chain which elevates logs into the mill. (Gen.)

Syn.: jack works (Cal.), log jacker, log haul, log haul-up, log hoist.

2. *See* Log haul-up.

Log jacker. *See* Log jack.

Log kicker. A lever device located on the log deck, by means of which logs are thrown out of the log trough onto the deck. (Gen.)

Syn.: log flipper, log roller, log unloader.

Log lift. A device sometimes used at sawmill plants, on tide-water, to elevate logs to the log deck. Logs are floated alongside the mill, parallel with the log deck, and are lifted vertically by chain or cable slings spaced several feet apart. One end of each chain or cable is fastened to the deck and the other end is attached to a power-driven shaft hung on beams above the water.

Log loader. *See* Log stop and loader.

Log maker. *See* Bucker.

Log roller. 1. At a portable sawmill plant, one who assists the sawyer in placing logs on the carriage. (N. F.)

Syn.: juggler, rail sawyer, turner.

2. *See* Log kicker.

Log run. In softwoods, merchantable lumber of all grades as it comes from the saw; in hardwoods, the full run of the log with No. 3 common out.

Log saddle. *See* Log dog.

Log saw. *See* Head saw.

Log scale. The contents of a log, or of a number of logs considered collectively. (Gen.)

Log seat. *See* Log dog.

Log shoe. *See* Log dog.

Log slip. *See* Log haul-up.

Log sorter. *See* Mark caller.

Log spur. (Log.) *See* Spur.
(Lum.) *See* Log dog.

Log stamp. *See* Marking hammer.

Log stop and loader. In a sawmill, a device placed at the base of the deck to hold the logs in place, and also to aid in throwing them onto the carriage. (Gen.)
Syn.: deck stop (P. C. F.), log loader, steam kicker (Gen.).

Log, to. To cut logs and deliver them at a place from which they can be transported by water or rail, or, less frequently, at the mill. (Gen.)

Log turner. 1. A device usually attached to beams over the log deck, consisting of a drum driven by friction gearing, on which is wound a chain or cable used in turning logs on a sawmill carriage. (Gen.)
Syn.: bull wheel, overhead center, overhead turner.
2. A device actuated by a steam piston, consisting of two or more arms or skids and a hook which are used to shove or to turn logs on a saw carriage. Especially adapted for handling large and long logs. Its movements are controlled by the sawyer. (P. C. F.) *See* Steam nigger.
Syn.: Simonson log turner, steam log turner.

Log unloader. *See* Log kicker.

Log watch. *See* Head driver.

Log way. *See* Log haul-up.

London standard. A unit of European lumber measurement. It is based on a piece 13 inches by 9 inches in cross section by 12 feet in length equal to 27 feet board measure. One hundred and twenty (120) standards comprise a London standard hundred, equal to 3,240 feet board measure.
Syn.: Dublin standard, Irish standard.
See Christiana standard, Drammen standard, Quebec standard, St. Petersburg standard.

London standard hundred. *See* London standard.

Long butt, to. *See* Butt off, to.

Lookout. *See* Signal man.

Loose. In circular or band saw fitting, a saw is "loose" in those places which fall away too much from a straight edge. (Gen.)

Loose knot. A knot not held firmly in place. (Gen.)

Loose-tongued sloop. *See* Swing dingle.

Lop, *v.* To cut the limbs from a felled tree. (Gen.)
Syn.: top-lop. (E. C.)

Lot, *n.* A piece of standing timber, small in area. (N. F.)

Lubber lift, to. To raise the end of a log by means of a pry, and through the use of weight instead of strength. (N. F.)

Lug hooks. A pair of tongs attached to the middle of a short bar, and used by two men to carry small logs. (Gen.)
Syn.: timber carrier, timber grapple.

Lumber, *n.* 1. Timber sawed or split for use. (Gen.)
2. Timber sawed or split for use in building; that is, the manufactured product of logs. (Supreme Court of North Carolina, 82 Southeastern, 1036.)

Lumber, *v.* To log or to manufacture logs into lumber, or both. (Gen.)

Lumber buggy. A two-wheeled truck for transporting lumber around a sawmill plant and yards. (Gen.)
Syn.: buggy, dolly (Gen.), lumber truck (P. C. F.).

Lumber gauge. A tool used to measure the thickness of a board, or to determine the accuracy of the manufacture of the tongue and groove which have been cut on a piece of surfaced lumber. (Gen.)

Lumberjack, *n.* One who works in a logging camp. (Gen.)
Syn.: timber beast, woodhick (App., N. W.), logger (P. C. F.), shanty man (E. C.).

Lumber jack. A stand or tripod, usually armed at the peak with a spike, which is used as a fulcrum in jacking lumber up to the top of a lumber pile. (Gen.)

Lumber kiln. *See* Dry kiln.

Lumber piler. *See* Stacker.

Lumber stacker. *See* Stacker.

Lumber transfer. A set of lever arms, either power or hand operated, which are used to transfer timbers and boards from a set of live rolls to some other conveying device. The new direction of travel is usually at right angles to the original. (Gen.)
Syn.: trip. (P. C. F.)

Lumber truck. *See* Lumber buggy.

Machine feeder. One who feeds lumber into a machine in a planing mill. (Gen.)
Syn.: planer feeder.

Machine tailer. One who stands at the rear of a surfacing machine and sorts or grades the lumber as it comes from the machine. (S. F.)

Main line. *See* Skyline.

Mandrel, *n.* *See* Saw arbor.

Mark, *n.* A letter or sign indicating ownership, which is stamped on the ends of logs. (Gen.) *See* Bark mark.
Syn.: brand, end mark.

Mark caller. In sorting logs, one who stands at the lower end of the sorting jack and calls the different marks, so that the logs may be guided into the proper channels or pockets. (Gen.)
Syn.: log sorter. (N. W.)

Marker, *n.* (Log.) 1. One who puts the mark on the ends of logs. (Gen.)
2. One who marks boles into log lengths for buckers. (Cal.)
(Lum.) 1. At a portable sawmill plant, one who takes lumber from behind the saw, scales, marks, and tallies it. (N. F.)
Syn.: scaler, surveyor.
2. One who grades lumber and places the grade symbol on each piece. (P. C. F.)

Market, *n.* A log 19 inches in diameter at the small end and 13 feet long. (New York.) *See* Quebec standard.
Syn.: standard.

Marking hammer. A hammer bearing a raised device which is stamped on logs to indicate ownership. (Gen.)
Syn.: marking iron (Gen.), log stamp, stamping hammer (E. C.).

Marking iron. *See* Marking hammer.

Match, *v.* *See* Mate.

Matcher, *n.* A surfacing machine used in a planing mill for finishing lumber of average width and thickness. (Gen.)
Syn.: joiner. (P. C. F.)

Mate, *v.* To place together in a raft, logs of similar size. (Gen.)
Syn.: match.

Merchantable (Merch.), *n.* The name of a specific grade of southern yellow-pine timbers. (Gen.)

Merchantable log. A log that will make lumber of a quality and in sufficient amount to make it profitable to take it to a mill and have it sawed. (Supreme Court of Michigan, 82 Northwest. Reporter, 230.)

Merchantable lumber. As applied to the output of a sawmill, the entire cut of the mill, except mill culls. (Gen.)

Merchantable timber. Usually interpreted to mean timber that can be manufactured and sold at not less than cost. The purpose for which the timber is to be used and local custom are factors which influence the degree of utilization.

Messenger. *See* Haul back.

Mill cull. 1. The non-merchantable part of the mill cut. (Gen.)
2. In hardwoods and some softwoods, a term applied to a specific quality of low-grade timber.

Mill deck. *See* Log deck.

Mill pond. A pond in which logs are stored at the mill. (Gen.)

Mill run. As generally understood, all of the lumber output of a sawmill which has a sale value. (Gen.)

Mill saw. *See* Sash saw.

Mill scale. The scale of logs made at the rafting boom or at the sawmill. (Gen.)

Millwright, *n.* A skilled mechanic who works at building and keeping a mill in repair. (Gen.)

Mine prop. A small stull. (R. M. F.)

Molder, *n.* *See* Molding machine.

Molding, *n.* Interior trim of all kinds. The term is often applied to narrow strips of lumber worked in various patterns which are used to give a finished appearance to an interior. (Gen.)

Molding machine. A planing mill machine on which ceiling, molding, and other finished products of small dimensions are made. (Gen.)
Syn.: moulder. (P. C. F.)

Monitor, *n.* *See* Catamaran.

Moss, *v.* *See* Chink.

Mud, *v.* To fill with soft clay or mortar the crevices between the logs in a logging camp. It usually is preceded by chinking. (N. F.) *See* Chink.
Syn.: daub. (R. M. F.)

Mudboat, *n.* A low sled with wide runners, used for hauling logs in swamps. (S. F., N. F.)
Syn.: jumper. (N. W.)

Mudsill, *n.* 1. The bed piece or bottom timber of a dam which is placed across the stream, usually resting on rocks or in the mud. (Gen.)
Syn.: bottom sill.
2. Short pieces of timber placed crosswise underneath the main sill of each bent in a railroad bridge. (Gen.)

Mulay saw. A long stiff saw which is actuated by a pitman attached to the lower end. The upstroke is accomplished by means of a spring pole or some similar device. The saw is not stretched in a frame. *See* Gang saw; Sash saw
Syn.: Muley.

Mule cart. A 4-wheeled vehicle used in the Coastal Plain region for hauling logs. The logs are suspended under the axle of the rear wheels. (S. F.)

Mule-ear knot. *See* Spike knot.

Muley. *See* Mulay saw.

Mulligan car. *See* Camp car.

Natural draft dry kilns. A dry kiln in which heat is provided by steam pipes within the kiln, circulation of air being secured by means of ducts opening to the exterior. (Gen.)

Needle gate. In a logging dam sluiceway, narrow timbers or poles with two or more squared faces which are placed in contact across the opening of the sluice to prevent the outflow of water. One or more "needles" may be removed without disturbing the remainder. (Gen.)
Syn.: bracket gate.

Nick. *See* Undercut.

Nigger, *n.* *See* Steam nigger.

Nipper, *n.* A member of the steel crew, who by means of a crow-bar and a block used as a fulcrum holds the end of the cross-tie against the base of the rail while the spikes are being driven. (Gen.)

Nominal measure. In the European import lumber trade, the full measure of a board before it is surfaced.

North Carolina pine. Pine lumber cut in the Coastal Plain region of Virginia, North Carolina, and South Carolina. (S. F.)

Nose, *v.* To round off the end of a log in order to make it drag or slip more easily. (Gen.)
Syn.: snipe.

Notch, *n.* *See* Undercut.

Notch, *v.* To make an undercut in a tree preparatory to felling it. (Gen.)
Syn.: box, undercut.

Novelty siding. *See* Drop siding.

Odd lengths. A term applied to lumber the length of which is in odd feet. (Gen.)

Off bear. *See* Off bearer.

Off bearer, *n.* One who stands directly behind the log saw in the mill and seizes slabs and boards as they come from the saw, placing them flat on live rollers. (Gen.)
Syn.: off bear, saw tailer, swamper, tail sawyer, take-away man, slab stripper. (S. F.)

Offset, *n.* A device attached to a sawmill carriage frame and also to one of the axles of the carriage trucks, which automatically shunts the carriage frame away from the saw line when the carriage is gigged back. (Gen.)

Ogee (O. G.). One of the most widely used moldings, having a double curve formed by a concave and a convex line. (Gen.)

One-block hold. *See* Block hold.

Open, *v.* *See* Tension.

Open-fire kiln. *See* Arkansas dry kiln.

Open up a saw, to. To increase the tension. (Gen.)

Out of round. A circular saw is said to be "out of round" when its periphery is not a perfect circle. (Gen.)

Output, *n.* *See* Cut.

Overhang, *n.* The forward pitch given to a pile of lumber. (Gen.)

Overhead canter. *See* Log turner.

Overhead saw. *See* Top saw.

Overhead trimmer. A trimmer, the saws of which are hung above the trimmer table. (Gen.) *See* Trimmer.

Overhead turner. *See* Log turner.

Overrun, *n.* The difference between the mill cut of merchantable lumber and the log scale. Usually calculated as a per cent of 1,000 feet log scale. (Gen.)

Overside delivery. Delivery direct from a vessel to a scow or barge.

Paddle, *n.* (Turp.) A small piece of wood which is placed over a cup during the chipping process, in order to keep trash from falling into the receptacle. (S. F.)

Pair of fallers. *See* Falling crew.

Parbuckle, *n.* *See* Crotch chain.

Park, *v.* To collect cross-ties along a strip road, usually by hand. (R. M. F.)

Partition, *n.* A pattern of lumber used for interior partitions and similar work where both sides of the board are exposed. (Gen.)

Patent lath. *See* Byrkit lath.

Patent siding. *See* Drop siding.

Peak, *n.* (Turp.) The apex of the triangle above a box or cup at which the two faces meet. (S. F.)

Peaker, *n.* **1.** A load of logs narrowing sharply toward the top and thus shaped like an inverted V. (Gen.)
Syn.: wind splitter.
2. The top log of a load. (Gen.)

Peavey, *n.* A stout lever from 5 to 7 feet long, fitted at the larger end with a metal socket and spike and a curved steel hook which works on a bolt; used in handling logs, especially in driving. A peavey differs from a cant hook in having a pike instead of a toe ring and lip at the end. (Gen.) *See* Cant dog; Cant hook.

Pecky, *a.* A term applied to an unsoundness most common in bald cypress. (S. F.)
Syn.: peggy.

Peeler, *n.* (Log.) *See* Barker.
(Lum.) *See* Rotary veneer machine.

Peggy, *a.* *See* Pecky.

Petersburg standard. *See* St. Petersburg standard.

Petersburg standard hundred. *See* St. Petersburg standard.

Petrograd standard. *See* St. Petersburg standard.

Philadelphia fencing. A pattern of partition used in the eastern part of the United States.

Pickaroon, *n.* 1 A piked pole fitted with a curved hook, used in holding boats to jams in log driving and for pulling logs from brush and eddies out into the current. (Gen.)
(Lum.) *See* Hookaroon.

Pick the rear, to. *See* Sack the rear, to.

Pier dam. A pier built from the shore, usually slanting downstream, to narrow and deepen the channel, to guide logs past an obstruction, or to throw all the water on one side of an island. (N. F.)
Syn.: side pier, wing dam.

Pig, *n.* *See* Rigging sled.

Pigman, *n.* *See* Chaser.

Pig tail. An iron device driven into trees or stumps to support a wire or small rope. (P. C. F.)

Pike lever. *See* Hand pike.

Pike pole. A piked pole from 12 to 20 feet long, with or without a hook, used in holding boats to jams in driving and for pulling logs from brush and eddies out into the current. (Gen.)
Syn.: gaff. (E. C.)

Pile, *v.* *See* Stick.

Pile bottom. The foundation on which lumber is piled during seasoning in a yard. (Gen.)

Pile dam. A dam formed by a double row of piles between which are placed stones, gravel, and fine material to prevent the passage of water. (L. S.)

Piler. *See* Stacker.

Piling strip. *See* Sticker.

Pillar, *n.* *See* Prop.

Pin dote. Small rotten spots on the ends of logs. (Gen.)

Pine sawyer. A beetle of the genus Monohammus which attacks the sapwood of pine logs. (S. F.)

Pin knot. A knot which is sound and not more than one-half inch in diameter. (S. F., P. C. F.)

Pin worm holes. Small holes in timber and lumber made by the larvæ of certain beetles. (Gen.)

Pirate, *n.* A manufacturer who sells direct to a consumer at a place where retailers are in business. (Gen.)

Pit, *n.* (Log.) A skidway elevated so that its base is level with the logging car bunks. (App.)

(Lum.) **1.** A cleared space at the tail of a portable mill which is used for storing lumber.

Syn.: dump.

2. A hole in which the pit-sawyer stands when whip-sawing lumber. (Gen.)

Pit boy. One who takes staves from the saw and passes them on to a lister. (Gen.)

Syn.: stave catcher.

Pith knot. A sound knot with a pith hole in the center which is not more than one-fourth of an inch in diameter.

Pitch, *n.* The angle between the back of a tooth and a line drawn from the extreme point of the tooth to the back of a band saw or to the center of a circular saw. (Gen.)

Pitch pocket. In coniferous woods, an opening between the annual growth rings containing pitch. (Gen.)

Syn.: pitch seam. (P. C. F.)

Pitch seam. *See* Pitch pocket.

Pitch streak. In coniferous woods, a well-defined accumulation of pitch at one point. (Gen.)

Pitt, *n.* An elevated rollway or skidway whose base is level with the log-car bunks. (App.)

Pitt-saw, *n.* *See* Whip-saw.

Pit-sawyer, *n.* One who stands in the pit below the log and aids in operating a whip-saw. (Gen.)

Place, *n.* *See* Turpentine orchard.

Plain-sawed. All lumber which is not classed as quarter-sawed. (Gen.)

Syn.: bastard grain, flat grain, slash grain.

Plane, *v.* *See* Surface.

Planer and matcher. A machine used in a planing mill or wood-working factory to surface and match lumber. (Gen.) *See* Floorer. (P. C. F.)

Planer feeder. *See* Machine feeder.

Plank, *n.* **1.** A piece of lumber from 2 to 3 inches thick. (Gen.)

2. In the southern yellow-pine export trade, pieces 7 inches and up in width and from 2 to 2¾ inches in thickness. (S. F.)

3. A piece of lumber 8 feet or more in length, more than 11 inches in width, and from 1½ to 4½ inches in thickness. (English markets.)

Plug, *n.* A steel pin about 2 inches in diameter and 18 inches long. Two of the plugs are joined together by chains which are attached to a large ring. They are used on pullboat operations in a cypress swamp in place of skidding tongs. (S. F.)

Syn.: puppy.

Plug and knock down. A device for fastening boom sticks together in the absence of chains. It consists of a withe secured by wooden plugs in holes bored in the booms. (N. F.)

Poacher, *n.* 1. A retail lumber dealer who encroaches on the sales territory of another dealer. (Gen.)
2. A wholesale lumber dealer who sells lumber to a retail lumberman, and then sells to the same retail lumberman's customers. (Gen.)

Pocket boom. A boom in which logs are held after they are sorted. (Gen.)

Point, *n.* *See* Bit.

Point, *v.* (Lum.) In hoop making, to bevel both sides of the lapped end of the hoop. (Gen.)
(Log.) *See* Gun.

Pointer, *n.* *See* Tripper.

Pokelogan, *n.* A bay or pocket into which logs may float during a drive. (N. W., L. S.)
Syn.: logan, set back.

Pole chute. *See* Fore-and-aft road.

Pole stock. Lumber used in the manufacture of poles for vehicles. (Gen.)

Pole tie. A tie made from a stick of timber yielding only one tie. (Gen.)

Pole tram road. A logging road, the rails of which are round poles. (App., S. F.)

Pond man. One who collects logs in the mill pond and floats them to the log haul-up. (Gen.)
Syn.: boom man, slip man (P. C. F.), jacker (N. W.), jackerman (S. F.).

Pond saw. A power-driven saw used to cross-cut logs at a sawmill pond. (Cal.)

Pontoon, *n.* *See* Catamaran.

Pony band mill. *See* Resaw.

Porch decking. A board surfaced and tongued and grooved whose upper face has two or more semicircular depressions for carrying off rain water, and whose lower surface often is beaded for ornamental purposes. It is used for porch roofing. (Gen.)

Portable mill setting. *See* Setting.

Portable sawmill. A small sawmill which can be readily moved from one place to another. The usual daily capacity varies from 3 M to 10 M board feet. (Gen.)

Post, *n.* *See* Prop.

Potter, *n.* A round stick, 3 or 4 inches in diameter and 2½ or 3 feet long, around the center of which is fitted an iron clasp to which is fastened a short piece of chain with a hook on the free end. It is used when loading logging sleds to prevent logs from rolling off the far side of the load until binding chains are placed in position. (N. W.)

Pouch, *n.* A French term applied derisively by lumber jacks to woods workers who shift from camp to camp. (N. W.) *See* Camp inspector.

Preparer, *n.* *See* Fitter.

Press roll. A live roll which holds the lumber against the feed roll when lumber is being fed into a machine. (Gen.)

Prime log. In the export market, one that is free from defects. (Gen.)

Prize log. A log which comes to the sorting jack without marks denoting ownership. (N. F.) *See* Stray.

Progressive dry kiln. A dry kiln in which the lumber is gradually advanced through the kiln, a few cars being taken out of the dry end at certain intervals and the remaining cars advanced to the dry end. The "green" end of the kiln then receives cars of unseasoned lumber. (Gen.)

Prop, *n.* In mining, a round, squared, or split timber which supports the cap and lagging or which is placed directly under the roof to support the same without a cap or lagging. (Gen.)
Syn.: pillar, post, stull.

Pull back. *See* Haul back.

Puller, *n.* (Turp.) A strong knife with a curved edge, fastened to a long handle. It is used to chip timber during the third and following years, when the face has advanced so far up the tree that it cannot be chipped with a hack. (S. F.) *See* Hack.

Pulling, *a.* (Turp.) A term applied to a cup or box that is hacked with a puller. (S. F.)
Syn.: three-year old.

Pulling face. (Turp.) One that is hacked with a puller. (S. F.)
Syn.: high face.

Pull the briar, to. To use a cross-cut saw. (N. F.)

Pull boat. A flatboat, carrying a steam skidder or a donkey, used in logging cypress. (S. F.)

Punch bar. One of the arms on a log kicker. (P. C. F.)

Puppy, *n.* *See* Plug.

Push. *See* Camp foreman.

Put in, to In logging, to deliver logs at the landing. (Gen.)

Quarter-sawed. In hardwoods, lumber cut parallel, or nearly parallel, with the medullary rays. In softwoods, lumber in which the annual growth rings do not tip more than 45° from the vertical throughout the entire length of the board. (Gen.)
Syn.: center-sawed, comb-grained, edge-grained, figure-grained, rift-sawed, silver-grained, vertical-grained.

Quarter tie. A tie made from a stick of timber yielding four or more ties. (S. F.)

Quebec deal. *See* Deal.

Quebec standard. (Log.) A white pine log 22 inches in diameter, inside bark, at the small end and 12 feet long. A spruce or balsam log 14 inches in diameter inside bark at small end and 12 feet long. (E. C.) *See* Market.
(Lum.) Formerly a unit for the measurement of deals in transactions between producer and shipper. Now confined to the measurement of Ottawa pine deals. It is based on a piece 3 inches by 11 inches in cross section by 10 feet in length and contains 27½ feet board measure. One hundred (100) Quebec standards are known as a Quebec standard hundred.
See Christiana standard, Drammen standard, London standard, St. Petersburg standard.

Quebec standard hundred. *See* Quebec standard.

Quickwater, *n.* That part of a stream which has fall enough to create a decided current. (Gen.)
Syn.: white water. (N. W.)
Ant.: stillwater.

Radiator dry kiln. A kiln in which air is heated over coils of steam pipes and then forced by fans into the chamber containing the lumber. (Gen.)

Raft bundle. Logs bound together into a circular unit for towing. (S. F.)

Rafter dam. A dam in which long timbers are set on the up-stream side at an angle of from 20 to 40 degrees to the water surface. The pressure of the water against the timbers holds the dam solidly against the stream bed. (N. F.)
Syn.: self-loading dam, slant dam.

Rafting dog. A wedge-shaped piece of metal with a ring or eye in the blunt end. Dogs are driven into boom sticks and often into the timbers being rafted, the raft members being held together by chains, cables, or rope, passed through the rings or eyes.

Rafting pin. A round or wedge-shaped wooden pin used to wedge cable in the rafting pin holes on a raft. (Gen.)

Rag a wedge, to. To roughen the surface of a wooden wedge with an ax to prevent it from jumping out of the saw cut in frozen timber. (E. C.)

Rake, *v.* (Turp.) To clear away all grass and other inflammable material from the base of a bled tree. (S. F.)
Syn.: weed.

Raker, *n.* On a cross-cut saw, the chisel-like points, alternating with saw teeth, which loosen and remove the severed fibres from the saw cut. (Gen.)
Syn.: cleaner.

Ramp. *See* Dock.

Ram pike. A tree broken off by the wind, with a splintered end on the portion left standing. (N. F.)

Random width shingles. Shingles of widths varying from 2 to 16 inches. There is no uniformity of width in the shingles in each bundle. (Gen.)

Rank, *v.* To haul and pile regularly, as to rank bark or cordwood. (Gen.)
Syn.: yard. (N. W.)

Ranking bar. *See* Handbarrow.

Ranking jumper. A wood-shed sled upon which tanbark is hauled. (N. F.)
Syn.: bark dray. (App.)

Ratchet setter. *See* Block setter.

Ratline, *n.* A rope through which at intervals small pins are driven into the logs which are to compose a raft joint. Its purpose is to hold the logs together until the boom poles can be adjusted. (E. C.)
Syn.: rattling line.

Rattling line. *See* Ratline.

Rave, *n.* A piece of iron or wood which secures the beam to the runners of a logging sled. (N. W., L. S.)

Rawhide, *v.* To carry on one's back. Usually applied to the carrying of tanbark. (App.)

Rear, *n.* The up-stream end of a drive; the logs may be either stranded or floating. "Floating rear" comprises those logs which may be floated back into the current; "dry rear," those which must be dragged or rolled back. (Gen.)
Syn.: tail end. (N. W.)

Rear-end dogger. *See* Dogger.

Receder, *n.* A device on a sawmill carriage for receding the knees away from the saw line. It may comprise either a coiled spring properly adjusted on the set shaft, or a system of gears and a friction pulley by means of which the set shaft can be revolved. (Gen.)

Receiving boom. *See* Storage boom.

Red cypress. Cypress lumber which has a deep color. (S. F.)
Syn.: black cypress.

Red heart. *See* Firm red heart.

Red top. A western yellow-pine tree the foliage of which has a reddish appearance when attacked by beetles of the genus Dendroctonus. This occurs during the fall of the year after the tree is attacked. (R. M. F.)

Refuse, *n.* That portion of a tree which cannot be removed profitably from the forest or utilized profitably at the manufacturing plant. (Gen.)

Refuse burner. An open or inclosed structure in which surplus slabs, sawdust, bark, and other sawmill wood refuse are burned. The open burner consists of a brick, sheet metal, or wire screen erected between the sawmill building and the open fire, while the inclosed type consists of a round brick or steel

structure with fire grates at the base and a fire screen over the top to prevent the emission of large sparks. (Gen.) *See* Slab-pit.
Syn.: burner, hell, incinerator.

Refuse conveyor. An endless chain traveling in a trough which transports sawmill refuse. (Gen.)
Syn.: slab conveyor.

Refuse grinder. *See* Hog.

Reject. A cross-tie made by a contractor that is not accepted on inspection by the camp foreman. (R. M. F.)

Renter, *n.* (Turp.) One who sub-contracts for or rents an area of cups or boxes and supplies all labor for chipping and dipping. Usually he is paid on the basis of the number of barrels of dip and scrape gathered. (S. F.)

Resaw, *n.* A circular or band mill which is used to resaw boards, cants, plank, timbers, slabs, and other wood products. (Gen.)
Syn.: pony band mill, slab saw.

Resaw, *v.* To cut boards, planks, slabs, or other material into two or more pieces on a resaw. (Gen.)

Resaw tailer. In a sawmill, one who takes care of the refuse material and boards as they come from the resaw. (Gen.)

Resawyer, *n.* One who operates a resaw. (P. C. F.)

Resin, *n.* *See* Crude turpentine.

Return line. *See* Haul back.

Rick, *n.* A pile of cordwood, stave bolts, or other material split from short logs (Gen.)
2. A pile of firewood 8 feet long, 4 feet high, and a width equal to the length of one stick. (C. H. F.)

Ride, *n.* The side of a log upon which it rests when being dragged. (Gen.).

Ride a log, to. To stand on a floating log. (Gen.)

Ridge runner. A farmer who is an intermittent logger. (App.)

Rift gang edger. A machine for sawing from 3-inch to 8-inch cants into edge-grained boards or into scantlings. (Gen.)
Syn.: bull edger.

Rift saw. A circular saw having four or more arms which project from the plate and carry the cutting teeth, usually of the inserted type. The indentations between the arms serve as cavities for the storage and removal of sawdust. Rift saws are used in cutting flooring strips from cants. (Gen.)

Rift-sawed. *See* Quarter-sawed.

Riga "last." A European unit of lumber measurement comprising 960 feet board measure of sawed deals or squared timbers.

Rigger. *See* Rigging slinger.

Rigging, *n.* The cables, blocks, and hooks used in skidding logs by steam power. (Gen.)

Rigging sled. A sled used to haul hooks and blocks on a skid road. (P. C. F.)
Syn.: chute boat, dog boat, pig.

Rigging slinger. 1. A member of a yarding crew, whose chief duty is to attach chokers which have been placed around logs to the pulling line. (P. C. F.)
2. One who attaches the rigging to spar or tail trees in steam skidding (S. F.)
Syn.: rigger.

Right-hand sawmill. A sawmill in which, when standing on the log deck and facing the rear of the mill, the carriage and saw are on the right hand. (Gen.)
See Left-hand sawmill.

Rim, *n.* One of the two pieces which comprise the curved rim of a wheel, between the spokes and the tire. It is a straight piece of lumber which is bent in the shape of a semicircle. (Gen.) *See* Felloe.

Ring, *n.* A section of tanbark, usually 4 feet long. (N. F.)

Ring rot. Decay in a log, which follows the annual rings more or less closely. (Gen.)

Rip, *v.* To cut a board lengthwise; *i. e.*, parallel to the fibers. (Gen.)

Rip saw. A saw which is used to rip lumber. (Gen.)

Rise, *n.* The difference in diameter, or taper, between two points in a log. (Gen.)

Rive, *v.* To split shingles or shakes from bolts. (Gen.)

River boss. The foreman in charge of a log drive. (N. F.)

River driver. One who works on a log drive. (Gen.)

River hog. *See* River rat.

River pig. *See* River rat.

River rat. A log driver whose work is chiefly on the river; contrasted with laker. (N. F.)

Syn.: river hog, river pig (N. W.). *See* Cattyman.

Road donkey. *See* Roader.

Road engine. *See* Roader.

Roader, *n.* A donkey engine mounted on a heavy sled, which is used for long-distance hauling either on the ground or on a skid road. It is equipped with three drums—one for the pulling line, one for the haul back, and one for loading. (P. C. F.) *See* Yarding donkey.

Syn.: bull donkey, road donkey, road engine (P. C. F.), Takoma (Cal.), donkey.

Road gang. That portion of the crew of a logging camp that cuts out logging roads and keeps them in repair. (N. F.)

Road monkey. One whose duty is to keep a logging road in proper condition. (N. W., L. S., P. C. F.)

Syn.: blue jay, chickadee (N. F.), sandman.

Road roller. A flanged roller placed upright at a bend in a skid road to direct the cable. It is sometimes used instead of a bull block in yarding logs. (P. C. F.)

Syn.: dolly, roller, stump roller, stump spool, upright roller, yarding spool.

Road scale. The scale of logs which is taken on the landing. (P. C. F.)

Rocker, *n.* The top bunk on the forward pair of runners of a logging sled. It is fastened to the lower bunk by a kingpin. (N. W.)

Rock saw. A circular saw or a planer cutter head, driven by a belt, which is suspended by a long arm above a log in front of the main saw. The rock saw removes a wide kerf on the upper surface of the log in the line of the head saw cut, and its object is to detect the presence of gravel, rafting dogs, and other foreign matter which might injure the main saw. The shavings and sawdust are removed by a suction hood. (P. C. F.)

Syn.: barking saw.

Rock sawyer. One who operates a rock saw. (P. C. F.)

Rodeur. *See* Camp inspector.

Roll, *n.* The crossbar of a logging sled in which the tongue is set. (N. W., L. S.)

Syn.: roller.

Roll a log, to. To so attach a choker to a log that the latter rolls sidewise when power is applied to the cable. (P. C. F.)

Roll bark. Hemlock tanbark that has not been carefully dried and hence is of inferior quality. (N. F.)

Roll-down man. *See* Tailer-in.

Roller, *n.* *See* Roll; Road roller.

Rolling chain. *See* Loading chain.

Rolling dam. A dam for raising the water in a shallow stream. It has no sluiceways, but a smooth top of timber over which, under a sufficient head of water, logs may slide or roll. (Gen.)

Roll logs, to. To turn over the logs on a landing so that the bark marks can be inspected by the scaler. (E. C.)

Roll the boom, to. To roll a boom of logs along the shore of a lake against which it is held by wind, by the use of a cable operated by a steamboat or kedge. The cable is attached to the outer side of the boom, hauled up, then attached again, thus propelling the boom by revolving it against the shore when it would be impossible to tow it. (N. W., L. S.)

Roll up. *See* Bank up.

Rollway, *n.* 1. (Lum.) A platform at the mill onto which logs are unloaded from log cars. It may be built around the edge of a pond or along the bank of a stream to aid in dumping the logs into the water, or it may be so built that it is used as a place for dry land storage of logs. (Gen.)
Syn.: log deck (Cal.), log dump.
(Log.) *See* Landing.

Roof board. *See* Shake.

Roofers, *n.* One-inch lumber nailed to rafters as a backing for shingles. (Gen.)

Rooster, *n.* *See* Gooseneck.

Rosin, *n.* In the distillation of crude turpentine, the residue remaining after the volatile oils have been driven off. (Gen.)

Rosser, *n.* 1. One who barks and smooths the ride of a log in order that it may slide more easily. (N. F.)
Syn.: log fixer, rosser (P. C. F.), scalper, slipper (App.).
2. One who peels pulpwood and logs. (N. W.)
3. *See* Barker, 2.

Rossing-mill, *n.* A plant at which bark is removed from pulpwood by means of machinery. (N. W., E. C.)

Rotary saw. *See* Circular saw.

Rotary veneer machine. A machine that cuts or peels a thin endless sheet of wood from a round log. (Gen.)
Syn.: peeler.

Rotten knot. A knot which is not as hard as the surrounding wood. (Gen.)

Rough-and-tumble landing. *See* Landing.

Rough woods. (Turp.) A forest that has not been burned over. (S. F.)

Round, *n.* *See* Course.

Round boom. A limber boom used to impound logs during towing. (L. S.) *See* Bag boom.

Round knot. A knot that is oval or circular in form. (Gen.)

Round timber. Timber which has not been bled for crude turpentine. (S. F.)

Rudder boom. *See* Fin boom.

Run, *n.* A narrow trail, cleared of brush and stumps, down which logs are pulled by a power skidder. (S. F.)

Run cutter. One who clears narrow trails which radiate from a pullboat or from a head-spar tree, down which logs are hauled by a power skidder. (S. F.)

Runner chain. A chain bound loosely around the forward end of the rear pair of runners of a logging sled as a brake. (N. W., L. S.)

Runner dog. A curved iron attached to the hind sled of a logging sled, which holds the loaded sled on steep hills by being forced into the bed of the road by any backward movement. (N. F.)

Running. *See* Cupping.

Running slide. A slide on which logs run by gravity. (App.)

Runway. *See* Gutter road.

Rustic siding, *n.* *See* Drop siding.

Rutter, *n.* A form of plow for cutting ruts in a logging road for the runners of the sled to run in. (N. W., L. S.)

Sack the rear, to. To follow a drive and roll in logs which have lodged or grounded. (Gen.)
Syn.: pick the rear, to; sweep the rear, to (E. C.)

Sack the slide, to. To return to a slide logs which have jumped out. (Gen.)

Saddle, *n.* The depression cut in a transverse skid in a skid road to guide the logs which pass over it. (P. C. F.)

Saddlebag, *v.* As applied to a boom, to catch on an obstruction and double around it. (Gen.)

St. Petersburg standard. A unit of lumber measurement in Europe. It is based on a piece 1½ inches by 11 inches in cross section by 12 feet in length, which is equal to 16½ feet board measure. One hundred and twenty (120) standards are known as St. Petersburg standard hundred, equal to 1,980 feet board measure, or 165 cubic feet.
Syn.: Petersburg standard, Petrograd standard.
See Christiana standard, Drammen standard, London standard, Quebec standard.

St. Petersburg standard hundred. *See* St. Petersburg standard.

Sampson, *n.* 1. An appliance for loosening or starting logs by horsepower. It usually consists of a strong, heavy timber and a chain terminating in a heavy swamp hook. The timber is placed upright beside the piece to be moved, the chain fastened around it, and the hook inserted low down on the opposite side. Leverage is then applied by a team hitched to the upper end of the upright timber. (N. F.)
2. *See* Kilhig.
3. The hold in donkey logging in which the pulling line is placed on a block of wood or some other object, so that the forward end of the log is raised as it starts forward. (P. C. F.)

Sampson a tree, to. To direct the fall of a tree by means of a lever and pole (N. F.)

Sandman. *See* Road monkey.

Sapper. *See* Knee bolter.

Sap stain. The stain on the sapwood of logs and lumber caused by fungi. (Gen.) *See* Blued lumber.

Sash, *n.* The frame in which gang saws and sash saws are stretched. The frame moves up and down in vertical grooves or slides and is actuated by a pitman attached to the base. (Gen.)

Sash saw. A ribbon of steel, toothed on one edge, which is stretched in a sash or frame. The saws are used singly. Sash saws are employed only in water-power mills of limited capacity. (Gen.) *See* Gang saw; Mulay saw.
Syn.: gate saw, mill saw.

Satchel stick. A stick carried on the shoulder and used by a lumberjack to support his turkey. (App.)

Saw alive, to. To make all cuts on the log parallel. (Gen.)
Syn.: saw through and through, to.

Saw arbor, *n.* The shaft and bearings on which a circular saw is mounted. (Gen.)
Syn.: arbor, mandrel.

Saw around, to. In sawing, to cut from three or more faces of a log, the latter being turned in order to get the best quality of lumber. (Gen.)

Saw bill. The instructions given to a sawyer for sawing lumber of various kinds and sizes from given logs. (Gen.)

Saw boss. Foreman of the felling and log-making crews. (S. F.)
Syn.: captain (S. F.), bull bucker, head bucker (P. C. F.).

Saw carriage. *See* Carriage.

Saw fitter. *See* Filer.

Saw guide. A device for steadying a circular or band log saw. (Gen.)

Saw kerf. The width of cut made by a saw. (Gen.)

Sawmill, *n.* A plant at which logs are sawed into salable products. It includes all the machinery necessary for the operation of the plant and also the buildings and grounds on which it is located. (Gen.)

Saw tailer. *See* Off bearer.

Saw through and through, to. *See* Saw alive, to.

Saw timber. Logs suitable in size and length for the production of merchantable lumber.

Sawyer, *n.* (Lum.) One who controls the carriage and other machinery in sawing logs into lumber. The quality and quantity of lumber sawed depends on his judgment, skill, and speed. (Gen.)
Syn.: head sawyer. (P. C. F.)
(Log.) *See* Faller.

Scale, *v.* To measure the volume of logs. (Gen.)
Syn.: cull. (E. C.)

Scale book. A book especially designed for recording the contents of scaled logs. (Gen.)

Scaler, *n.* (Log.) One who determines the volume of logs. (Gen.)
Syn.: culler. (E. C.)
(Lum.) *See* Grader; Marker.

Scalper, *n.* (Lum.) One who sells, for a commission, lumber in which he has no direct financial interest. (Gen.)
(Log.) *See* Rosser.

Scantling, *n.* 1. A piece of timber of small size. (Gen.)
Syn.: stud, studding. (Gen.)
2. In the southern yellow-pine export trade, pieces from 2 by 2 to 2 by 6 inches, from 3 by 3 to 8 by 8 inches, from 4 by 4 to 4 by 8 inches, and from 5 by 5 to 5 by 8 inches in size. (S. F.)

Scarf, *v.* In stave making, to bevel the inner edge of a hoop just above the croze. (Gen.)

Schoodic chain bind. A method of binding logs to the bunk of a dray. Two forms are in use, namely, the single schoodic and the double schoodic. (N. W.)

Scoot, *n.* (Lum.) Hardwood lumber, all pieces being of a quality inferior to No. 4 Common.
(Log.) *See* Dray.

Score, *v.* In hewing timber, to mark with lines or with ax hacks the limits of the cut, both as to width and depth. (Gen.)

Scotch, *n.* *See* Gooseneck.

Scrape, *n.* Crude turpentine, from which certain volatile oils have evaporated. It accumulates on the scarified portion of a tree which is being bled for crude turpentine and is removed in the fall at the end of the season's operations. (S. F.)

Scrape, *v.* To collect scrape from the scarified portion of a tree which is being bled for crude turpentine. (S. F.)

Scrape iron. (Turp.) An instrument used in gathering scrape from faces. (S. F.)

Scratch grade. A logging railroad grade on which only light work has been done. (P. C. F., S. F.)

Screw rollers. Live rollers, with a coarse thread on the surface, which shunt the piece of lumber or slab to one side so that it will leave the roll. (Gen.)
Syn.: worm roller.

Seam. *See* Check.

Season, *v.* To dry lumber, either in the open or in a dry kiln. (Gen.)

Season check. *See* Check.

Season checks. Cracks which appear on the exterior faces of lumber during the seasoning process. (Gen.)

Season's cut. The output of a sawmill plant for that portion of the year the mill is operated. (Gen.)

Second faller. The subordinate in a crew of two fallers. (P. C. F.) *See* Head faller.
Syn.: faller, helper. (N. F.)

Second loader. *See* Head loader.

Section, *n.* A portion of a log raft, separated by swifters, usually containing two tiers of logs. (P. C. F.)

Select structural (Sel. struc.). The name of a specific grade of southern yellow-pine timbers. (Gen.)

Self-loading dam. *See* Rafter dam.

Self-loading skidder. *See* Bummer.

Sender. *See* Ground loader.

Send-in man. One who has charge of securing and sending to the planing mill such lumber as is called for by the shipping clerk. (Gen.)

Send-up man. *See* Ground loader.

Send up, to. In loading, to raise logs up skids with cant hooks or by steam or horse power. (Gen.)

Set back. *See* Pokelogan.

Set beam. A shaft on a sawmill carriage, directly connected with the set works, bearing pinions one of which meshes into a rack in each headblock and moves the knees forward and backward as desired. (Gen.)

Set gauge. A tool used by a cross-cut saw filer to regulate the amount of set given to each tooth. (Gen.)
Syn.: spider.

Setter, *n.* *See* Block setter.

Setting, *n.* (Lum.) The temporary station of a portable sawmill. (Gen.)
Syn.: portable mill setting, set-up.
(Log.) The temporary station of a yarding engine, or other machine used in logging. (Gen.)
Syn.: set-up.

Setting block. A small steel block on which the tooth of a cross-cut saw is placed and then struck with a hammer to give it the proper set. (Gen.)

Set-up, *n.* *See* Setting.

Set works. The mechanism on a sawmill carriage by means of which the block setter advances the knees and the log toward the saw line after a piece has been cut from the log. (Gen.)

Set works scale. A disc on a saw carriage which shows the distance in inches between the saw line and the face of the knees. (Gen.)
Syn.: dial, gauge.

Shackle. *See* Yoke.

Shade streak. (Turp.) A streak so chipped that it shades the newly exposed surface from the direct rays of the sun. (S. F.)

Shake, *n.* 1. A form of shingle split from a bolt of wood and used to cover both the roofs and sides of buildings. Those made of sugar pine are 32 inches long, 5 inches wide, and 3/16 of an inch on the thinner edge.
Syn.: hand-made shingle, roof board. (App.)
2. A crack in timber, due to frost or wind. (Gen.)
Syn.: windshake.

Shake roof. *See* Split roof.

Shank, *n.* A device for locking inserted teeth in a circular saw. (Gen.)
Syn.: holder.

Shanty boat. *See* Wanigan.

Shanty boss. 1. *See* Camp foreman.
2. *See* Chore boy.

Shanty man. *See* Lumberjack.

Shear boom. A boom so secured that it guides floating logs in the desired direction. (N. F.)
Syn.: fender boom, glancing boom.

Shear skid. *See* Fender skid.

Sheathing, *n.* Lumber used to cover the exterior of buildings. (Gen.)

Sheathing lath. *See* Byrkit lath.

Shelter house. (Turp.) A small shed erected in the woods in which workmen may take shelter during storms. (S. F.)

Shim, *n.* Blocking placed under cross-ties to level up the track; also used to keep the track from sinking into the mud. (Gen.)

Shim up, to, *v.* To place shims under a railroad track. (Gen.)

Shingle, *n.* A thin, oblong piece of wood, with one end thinner than the other, in order to lap lengthwise in covering roofs and outer walls of buildings. (Gen.)

Shingle bolt. A short split section of a log from which shingles are manufactured. (Gen.) *See* Bolt.

Shingle bundler. *See* Shingle packer.

Shingle jointer. *See* Knot saw.

Shingle mill. 1. A mill in which shingles are manufactured. (Gen.)
2. A machine used in making shingles. (Gen.)

Shingle packer. 1. One who packs shingles in bundles. (Gen.)
Syn.: shingle bundler.
2. *See* Shingle press.

Shingle press. A frame in which shingles are packed in bundles.
Syn.: shingle packer.

Shingle saw. A circular saw used to cut shingles from bolts. (Gen.)

Shingle weaver. One who works in a shingle mill. (P. C. F.)

Shiplap, *n.* 1. A form of matching for lumber. A section one-half the thickness of the board is cut from the upper side of one edge, and a similar section from the lower side of the opposite edge. (Gen.)
2. Lumber which has been worked shiplap. (Gen.)

Ship lumber, to. 1. To load lumber on cars or vessels for shipment, or to place lumber in the upper end of a flume for transportation. (Gen.)
2. To transport lumber by rail or water. (Gen.)

Shipping dry. A condition of lumber in which the moisture content is the same as that of air-dried lumber. (Gen.)

Shook, *n.* 1. A bundle of planed, seasoned, and jointed staves, containing a complete set for one barrel. (S. F.)
2. *See* Box shooks.

Shoot a jam, to. To loosen a log jam with dynamite. (Gen.)

Shop, *n.* A quality of lumber in several grades which is used in the manufacture of sashes, doors, blinds, and like products. (Gen.)

Shore hold. The attachment of the hawser of a raft of logs to an object on the shore. (N. W., L. S.)

Short road. *See* Go-back road.

Shorts, *n.* Lumber shorter than standard lengths. (Gen.)

Shot-gun, *n.* *See* Gun.

Shot-gun feed. *See* Steam feed.

Shot holes. Holes made in wood by boring insects. (App.)

Shoulder, *n.* (Turp.) The uppermost corner of a face. The streak starts at the shoulder and terminates at the peak. (S. F.)

Shove-off man. One who consecutively shoves off the top courses of lumber on a dry-kiln truck when the latter is being unloaded. (Gen.)

Show, *n.* *See* Chance.

Side, *n.* The crew of men, including fallers, buckers, rigging men, loaders, and all others working with a yarding donkey. Where a roader or swing donkey takes logs from the yarding donkey the men operating them are included in the side. (P. C. F.)

Side boss. The foreman of a "side." (P. C. F.)

Side camp. (Turp.) Quarters for laborers, at some distance from the main camp where the still is located. (S. F.)

Side jam. A jam which has formed on one side of a stream, usually where the logs are forced to the shore at a bend by the current or where the water is shallow or there are partially submerged rocks. (N. F.)

Side line logs, to. 1. To throw the hauling cable around a stump, out of the direct line of pull, in order to change the direction of travel of the log and thus avoid some obstruction in its path. (Gen.)
Syn.: siwash. (P. C. F.)
2. To draw logs up to the main hauling cable. (S. F.)

Side-line man. One who carries the side lines from the main cable of a pullboat and attaches them to the logs that are to be skidded. (S. F.)

Side mark. *See* Bark mark.

Side pier. *See* Pier dam.

Side pole. *See* Sway bar.

Side sawyer. An assistant to a stave sawyer. His duty is to place the bolt on the carriage, to keep it fed laterally against the cylinder saw and to aid in gigging back the carriage. (S. F.)

Side winder. A tree knocked down unexpectedly by the falling of another. (Gen.)

Siding, *n.* *See* Bevel siding; Drop siding.

Sidings, *n.* Boards sawed from the outer portion of a log when the central part is made into a timber. (N. F.)

Signal man. One who transmits orders from the foreman of a yarding crew to the engineer of the yarding donkey.
Syn.: lookout, signal punk, whistle punk.

Signal punk. *See* Signal man.

Silver-grained. Quarter-sawed lumber with conspicuous medullary rays. (Gen.) *See* Quarter-sawed.

Simonson log turner. *See* Log turner.

Single band saw. A saw that has one cutting edge. (Gen.)

Single cord. A pile of wood, 8 feet long, 4 feet high, and 2 feet wide. (C. H. F.)

Single coupler. Single coupling grabs joined by a short chain or cable, used for fastening logs together. (App.)
Syn.: tail grab.

Single cut, to. To float logs, usually cypress, one at a time from the woods to the front road. (S. F.)

Single mill. A sawmill having one head saw. (Gen.)

Sinker, *n.* *See* Deadhead.

Sinker boat. *See* Catamaran.

Siwash. *See* Side line logs, to; Jackpot.

Sizer, *n.* A machine for surfacing timbers. (Gen.)
Syn.: dimension planer, timber planer. (P. C. F.)

Skeleton log car. A car having a skeleton frame. (Gen.)
Syn.: connected truck. (P. C. F.)

Skewer, *n.* Round wooden pins of varying length and diameter, and pointed at one end. They are most extensively used in packing-houses and butcher shops to hold meat together. (Gen.)

Skid, *v.* 1. To draw logs from the stump to the skidway, landing, or mill. (Gen.)
Syn.: snake, twitch, yard. (N. W.)
2. As applied to a road, to re-enforce by placing logs or poles across it. (Gen.)

Skidder, *n.* 1. One who skids logs. (Gen.)
2. A steam or electrically driven device operating on or near a railroad track, which skids logs by means of a cable. Three general systems are in use: the cable-way or overhead system, the chief distinguishing feature of which is a cable suspended between a head-spar tree and a tail tree, on which travels a trolley from which cables run that wholly or partially elevate the log above the ground; the slack-rope system, a ground system in which the skidding cable is returned to the logs by a smaller cable called a messenger cable; the snaking system, a ground system in which the skidding line is pulled out by an animal. (Gen.)
Syn.: steam skidder.
3. The foreman of a crew which constructs skid roads. (P. C. F.)
4. *See* Bummer.

Skidding chain. A heavy chain used in skidding logs. (Gen.)

Skidding hooks. *See* Skidding tongs.

Skidding sled. *See* Dray.

Skidding tongs. 1. A pair of hooks attached by links to a ring and used for skidding logs. (Gen.)
Syn.: dogs, grabs, grapples, grips, head grabs, skidding hooks.
2. Tongs used in skidding logs. (Gen.)

Skidding trail. *See* Gutter road.

Skid grease. *See* Chute grease.

Skid greaser. *See* Greaser.

Skid man. *See* Dock man.

Skid-off, *n.* A launching way for lumber rafts. (S. F.)

Skid road. 1. A road or trail leading from the stump to the skidway or landing. (Gen.)
Syn.: travois road. (N. F.)
2. A road over which logs are dragged, having heavy transverse skids partially sunk in the ground, usually at intervals of about 5 feet. (P. C. F.)

Skids, *n.* Logs or poles, commonly used in pairs, upon which logs are handled or piled (Gen.); or logs or poles laid transversely in a skid road. (P. C. F.)

Skid up, to. 1. To level or re-enforce a logging road by the use of skids. (Gen.)
2. To collect logs and pile them on a skidway. (Gen.)

Skidway, *n.* Two skids laid parallel at right angles to a road, usually raised above the ground at the end nearest the road. Logs are usually piled upon a skidway, as they are brought from the stump for loading upon sleds, wagons, or cars. (Gen.)
Syn.: yard. (N. W.)

Skidway, to break a. To roll logs off a skidway. (Gen.)

Skips in dressing. In surfacing lumber, slight depressions in boards which are below the line of cut, and therefore remain in a rough condition. (Gen.)

Skip the grabs, to. To release the skidding grabs from the log by means of a grab skipper. (App.)

Skipper, *n.* 1. A sledge hammer with pointed ends which is used to pry skidding tongs loose from logs. (App.)
2. One of the poles placed on a skid road to facilitate the haulage of logs. (App.) *See* Skipper road.

Skipper road. A skid road on which poles are placed zigzag across the road, the angle between skids being about 60 degrees; or a road on which poles are placed transversely at intervals of from 4 to 6 feet. (App.)

Sky hooker. *See* Top loader.

Skyline, *n.* The cable suspended between the head-spar tree and the tail tree in cableway logging, on which the trolley travels. (P. C. F.)
Syn.: aerial line, main line, track cable.

Skyline logging. Logging with a cableway skidder. (P. C. F.)

Slab, *n.* 1. The exterior portion of a log which is removed in sawing lumber. (Gen.)
2. In a box shook factory, a thin piece of lumber resawed from a board. (Gen.)

Slab conveyor. *See* Refuse conveyor.

Slab man. One who works on the sawing floor of a sawmill and keeps slabs out of the way of other material. (P. C. F.)

Slab pile. A place where slabs and other mill waste is burned or dumped. (Gen.)

Slab-pit. An open refuse burner. (S. F.) *See* Refuse burner.

Slab saw. *See* Resaw.

Slab slasher. *See* Slasher.

Slab streak. (Turp.) A streak so chipped that the entire surface of the newly exposed wood is turned outward toward the direct rays of the sun. (S. F.)

Slab stripper. *See* Off-bearer.

Slab tie. The third tie made from a stick of timber too small to make four ties and too large to make two ties. (S. F.)

Slack cooperage. Packages, consisting of two round heads and a body composed of one or more staves held together with hoops, which are used as containers for non-liquid products. When the package is composed of one or two staves only, the latter are made from large sheets of rotary cut veneer. (Gen.)

Slack puller. 1. A power-operated device on an overhead steam skidder which pulls slack out of the skidding line when the trolley has been run out to the desired point in the run. (Gen.)
2. One who pulls slack on the skidding line of an overhead steam skidder. (S. F.)

Slack-rope system. A system of power logging, in which the main skidding cable is returned from the machine to the woods by means of a smaller cable known as the "haul-back," or "messenger." (Gen.)

Slack water. 1. In river driving, the temporary slackening of the current caused by the formation of a jam. (Gen.)
2. Low water or dead water. (N. W.)

Slant dam. *See* Rafter dam.

Slash, *n.* 1. The debris left after logging, wind, or fire (Gen.)
Syn.: brush, slashing.
2. Forest land which has been logged off and upon which the limbs and tops remain, or which is deep in debris as the result of fire or wind. (Gen.)

Slash boards. *See* Splash boards.

Slasher, *n.* Several circular saws mounted on the same line at intervals from 16 to 48 inches, and used to cut slabs, edgings and other wood refuse into lengths suitable for lath, firewood, pulpwood, or for transportation to the refuse burner.
Syn.: slab slasher.

Slasher man. In a sawmill, one who tends the conveyor chains bearing refuse to the slasher. (Gen.)

Slash grain. *See* Plain-sawed.

Slashing, *n.* *See* Slash.

Slash knot. *See* Spike knot.

Slat, *n.* 1. In pencil manufacture a standard slat is a sawed piece of wood 7¼ by 2½ by ¼ inches from which pencils are made. (Gen.)
2. A strip used in the manufacture of crates. (Gen.)

Slat saw. A small circular saw on which small dimension stock is cut. (Gen.)

Sled tender. 1. One who assists in loading and unloading logs or skidding with a dray. (N. F.)
Syn.: chainer (L. S.), chain tender, chaser, frogger.

Sleigh. *See* Logging sled.

Slide, *n.* A trough built of logs or timber, used to transport logs down a slope, usually by gravity. (Gen.)
Syn.: chute, dry slide, slip.

Slide tender. One who keeps a slide in repair. (Gen.)

Slip, *n.* (Lum.) *See* Log haul-up.
(Log.) *See* Slide.

Slip grab. A pear-shaped link attached by a swivel to a skidding evener or or whiffletree, through which the skidding chain is passed. The chain runs freely when the slip grab is held sideways, but catches when the grab is straight. (N. F.)
Syn.: grab link.

Slip man. *See* Pond man.

Slipper, *n.* *See* Rosser.

Slip skids. *See* Glisse skids.

Slip-tongue cart. A special form of logging wheels used for transporting logs. (S. F., P. C. F.) *See* Logging wheels.

Sloop, *n.* 1. A single pair of long sled runners, equipped with a tongue and bunks on which short logs are loaded. Used chiefly in farming communities. (N. W.)
2. *See* Bob.

Sloop logs, to. To haul logs down steep slopes on a dray or sloop equipped with a tongue. (N. F.)

Slough pig. Usually a second-rate river driver who is assigned to picking logs out of sloughs in advance of the rear. (N. F.)

Sluice, *n.* *See* Flume.

Sluice, *v.* 1. *See* Flume.
2. To float logs through the sluiceway of a splash dam. (N. F.)
3. *See* Splash.
4. *See* Hand sluice,

Sluice gate. The gate closing a sluiceway in a splash dam. (N. F.)

Sluiceway, *n.* The opening in a splash dam through which logs pass. (Gen.)

Small knot. In cypress and Pacific Coast woods, a knot that is sound and not more than three-fourths of an inch in diameter.

Smoke-dried finish. Lumber that has been seasoned in an Arkansas dry kiln. It is usually blackened on the surface, due to exposure to smoke during the drying process. (S. F.)

Smoke kiln. *See* Arkansas dry kiln.

Snag, *n.* 1. A standing tree stem from which the crown has been broken. (Gen.) *See* Ram pike.

Syn.: stub.

2. A sunken log or a submerged stump. (Gen.)

Snake, *v.* (Lum.) In sawing, to make a wavy cut in a log. It is a sign of poor saw fitting. (Gen.)

(Log.) *See* Skid.

Snaking system. A system of power logging in which the main cable is returned to the woods by an animal. (Gen.)

Snaking trail. *See* Gutter road.

Snatch team. *See* Tow team.

Snib, *v.* In river driving, to be carried away purposely, but ostensibly by accident, on the first portion of a jam that moves; to ride away from work under guise of being accidentally carried off. (N. W., L. S.)

Snipe, *v.* *See* Nose.

Sniper, *n.* One who noses logs before they are skidded. (Gen.)

Snow a road, to. To cover bare spots in a logging road with snow, to facilitate the passage of sleds. (N. F.)

Snow slide. A temporary slide on a steep slope, made by dragging a large log through deep snow which is soft or thawing; when frozen solidly, it may be used to slide logs to a point where they can be reached by sleds. (S. W.)

Snub, *v.* To check, usually by means of a snub line, the speed of logging sleds or logs on steep slopes, or of a log raft. (Gen.)

Snubber, *n.* A device consisting of a drum or drums, controlled by powerful hand or power brakes, or both, which is used in lowering logs or log cars on steep grades, by means of a cable. (P. C. F.)

Snub line. 1. A rope or cable attached to the rear bunk of a logging sled used to control the speed on steep grades. (N. W.)

2. A wire rope used with a donkey for snubbing logs, or log cars. (P. C. F.)

Snub yoke. The wheelers in an ox team. (App., S. F.) *See* Butt team; Wheelers.

Soft gum. *See* Crude turpentine.

Softwood, *a.* As applied to trees and logs, needle-leafed, coniferous. (Gen.)

Softwood, *a.* As applied to lumber, that which is cut from coniferous trees. (Gen.)

Softwood, *n.* A coniferous tree. (Gen.)

Solid jam. 1. In river driving, a jam formed solidly and extending from bank to bank of a stream. (N. F.)

2. A drive is said to be "in a solid jam" when the stream is full of logs from the point to which the rear is cleared to the mill, sorting jack, or storage boom. (N. F.)

Solid-plate circular saw. *See* Solid-tooth circular saw.

Solid-tooth circular saw. A saw in which the teeth are cut into the periphery of the saw. (Gen.)

Syn.: solid-plate circular saw.

Sorter, *n.* *See* Chain sorter.

Sorting boom. A strong boom used to guide logs into the sorting jack, to both sides of which it is usually attached. (Gen.)

Sorting gap. *See* Sorting jack.

Sorting jack. A raft secured in a stream, through an opening in which logs pass to be sorted by their marks and diverted into pocket booms or the down-stream channel. (Gen.)
Syn.: sorting gap.

Sorting table. In a sawmill, a long platform extending from the rear on which lumber is assorted. (Gen.)

Sort lumber, to. To take lumber from the sorting table and pile it on cars or trucks in such manner that each species and grade may be taken to the proper part of the yard. (Gen.)

Sound cutting. In hardwood lumber, a piece that is free from rot and shake.

Sound knot. A knot which is solid across its face, as hard as the surrounding wood, and so fixed that it will retain its place in the piece. (Gen.)

Sound merchantable. As applied to lumber, a non-official, loosely interpreted term which does not represent any established grade. Usually interpreted as lumber that is salable for some specified purpose. (Gen.)

Sound wormy. A term applied to a particular quality of oak and chestnut lumber which contains pin worm holes. (Gen.)

Spalt, *n.* The residue of a shingle bolt, after cutting off shingles, which is too narrow to be cut into shingles. (P. C. F.)

Spanish windlass. A device for moving heavy objects in logging. It consists of a rope or chain, within a turn of which a lever is inserted and power gained by twisting. (N. F.)
Syn.: twister.

Spar tree. *See* Head-spar tree.

Spider. *See* Set gauge.

Spiked roller. Rolls either round or concave, which are armed with spikes and designed to feed logs or slabs against a saw. They are usually power driven. (Gen.)
Syn.: spiked rolls.

Spiked rolls. *See* Spiked roller.

Spiked skid. A skid in which spikes are inserted in order to keep logs from sliding back when being loaded or piled. (Gen.)

Spike knot. A knot sawed in a lengthwise direction. (Gen.)
Syn.: horn knot, mule-ear knot, slash knot. (P. C. F.)

Spike peddler. One who delivers spikes to spikers in a railroad track-laying crew. (S. F.)

Spiral grain. *See* Cross grain.

Spirits, *n.* *See* Turpentine.

Splash, *v.* To drive logs by releasing a head of water confined by a splash dam. (Gen.)
Syn.: flood, sluice.

Splash boards. 1. Boards placed temporarily on top of a rolling dam to heighten the dam, and thus to increase the head of water available for river driving. (N. F.)
Syn.: slash boards. (N. W.)
2. A false gate placed on the up-stream side of a lift gate as an aid in raising the latter. (N. W.)

Splash dam. A dam built to store a head of water for driving logs. (Gen.)
Syn.: cutaway dam (E. C.), flood dam (Gen.).

Splicer, *n.* One who splices cables on a logging operation. (P. C. F.)

Spline, *n.* A rectangular strip of wood which is substituted for the tongue on heavy factory flooring. (Gen.)

Split roof. A roof of a logging camp or barn made by laying strips split from straight-grained timber. The strips run from the ridge pole to the eaves, and break the joints with other strips, as in a shingle roof. (N. F.)
Syn.: shake roof (Cal.), trough roof (P. C. F.).

Split stave. A stave that is split from a stave-cut by means of a froe, mallet, and wedges. (Gen.)

Split staves, to. To make split staves. (Gen.)

Spoke billets. The rough sawed piece from which spokes are turned. (Gen.) *See* Blank.

Spoke bolt. *See* Bolt.

Spool bar. Small sawed squares of lumber from which spools are turned. (N. F.)
Syn.: spoolwood. (E. C.)

Spool donkey. A donkey engine equipped with a spool or capstan, instead of a drum. (P. C. F.)
Syn.: dolbeer (Cal.), gypsy yarder, donkey.

Spool tender. 1. One who guides the cable on a spool donkey. (P. C. F.)
2. One who operates the loading drum on a donkey. (P. C. F., R. M. F.)

Spoolwood. *See* Spoolbar.

Spot, *v.* 1. *See* Blaze.
2. To place logging cars at a loading point or opposite a landing. (S. F., P. C. F.)

Spotting line. A cable by which a log loader or power skidder moves itself for short distances; also a line used to pull empty log cars into position for loading. (S. F., P. C. F.)

Sprag. *See* Gooseneck.

Spreader, *n.* 1. A stout stick which holds apart the free ends of two chains which are attached to a large ring. The term is often applied to the entire rig. The spreader is used in skidding on rough bottom or on steep grades in place of a doubletree. (Gen.)
Syn.: equalizer, stretcher.
2. A piece of steel rail used to separate the loading hooks in loading with a gin pole. (P. C. F.)

Spring board. (Log.) A short board, shod at one end with an iron calk, which is inserted in a notch cut in a tree, on which the faller stands while felling the tree. (P. C. F.) *See* Bucking board.
Syn.: chopping board.
(Lum.) The support on which shingles rest while being jointed, so called because it springs back into place after having been pushed down so that the shingle is brought into contact with the saw. (Gen.)

Spring pole. 1. A springy pole attached to the tongue of a logging sled and passing over the roll and under the beam, for holding the weight of the tongue off the horses' necks. (N. F.)
2. A device for steadying a cross-cut saw so that one man can use it instead of two. (P. C. F.)

Spring set. A saw is spring set when one tooth is sprung slightly to the right and the next one to the left, and so on alternately throughout the saw. Cross-cut saws are spring set; also very narrow band saws. (Gen.)
Syn.: beveled dress, briar dress. (P. C. F.)

Sprinkler, *n.* A large wooden tank from which water is sprinkled over logging sled roads during freezing weather in order to ice the surface. (N. W., L. S.)
Syn.: ice box, tank, water box.

Sprinkler sleds. The sleds upon which the sprinkler is mounted. They consist of two sleds whose runners turn up at each end, fastened together by cross chains, each having a tongue, in order that the sprinkler may be hauled in either direction without turning around. (N. F.)

Spud, *n.* 1. A tool for removing bark. (Gen.)
Syn.: barking iron.
2. *See* Stump spud.

Spudder, *n.* *See* Barker.

Spur, *n.* A branch logging railroad. (Gen.)

Square, *n.* When applied to shingles, that number which will cover 100 square feet of surface. (Gen.)

Square dress, *n.* *See* Swage set.

Square dress, to. *See* Swage a saw, to.

Square Edge and Sound (Sq. Edg-Sd.). The name of a specific grade of southern yellow-pine timbers. (Gen.)

Stack, *v.* *See* Stick.

Stacker, *n.* 1. One who places lumber in piles. (Gen.)
Syn.: lumber piler, lumber stacker, piler.
2. A machine for stacking lumber on dry kiln trucks. *See* Edge stacker.
Syn.: lumber piler, lumber stacker.

Stag, *v.* To cut off trousrs just below the knee, or boots at the ankle. (N. F., P. C. F.)

Stamping hammer. *See* Marking hammer.

Standard, *n.* (Lum.) *See* Christiana standard, Drammen standard, London standard, Quebec standard, St. Petersburg standard.
(Log.) *See* Market.

Standard band sawmill. One containing a single band mill and having a rated capacity of 50 M board feet in 10 hours. (Gen.)

Standard knot. 1. A knot that is sound and not over 1½ inches in diameter. (S. F.)
Syn.: tight knot. (P. C. F.)
2. In hardwoods and cypress, a knot that is not more than 1¼ inches in diameter.

Standard lengths. Lengths into which rough lumber is cut for general use. The standard lengths in southern yellow pine are multiples of 2 feet, from 4 to 24 feet inclusive. In surfaced products, such as flooring, ceiling, drop siding, and like material, the standard lengths range in multiples of 1 foot, from 3 to 20 feet inclusive. Hardwood standard lengths run from 4 to 16 feet inclusive. In the Province of Quebec, Canada, the standard lengths are 12 and 13 feet.

Start, *n.* A pin or pins fastened to the runners of a dray and holding in place the upper removable bar or bunk. (N. W.)

Starting bar. *See* Gee throw.

Stationary sawmill. A sawmill that has a permanent location, as contrasted with a portable mill which may be moved at frequent intervals. (Gen.)

Stave bolt. One of the pieces of a stave-cut which has been split lengthwise into two or several pieces. (S. F.) *See* Bolt.

Stay boom. A boom fastened to a main boom and attached up-stream to the shore to give added strength to the main boom. (Gen.)

Stave bucker. A machine, by means of which rough staves are dressed to the proper shape and size. The dressing is done by revolving knives. (S. F.)

Steam bucking saw. A portable steam saw used for bucking logs at the landing. (Cal.)
Syn.: drag saw.

Stave catcher. *See* Pit boy.

Stave-cut. A section of a bole cut the length of a stave. (S. F.)

Stave sawyer. One who feeds bolts into a stave saw and gauges the thickness of the staves sawed. (S. F.)

Steam bucker. A stave bucker operated by steam power. (S. F.)

Steam dago. A power-driven log bucking device. (P. C. F.)

Steam dog. A device operated by a steam cylinder which is placed in the log trough on the deck of a sawmill in order to hold logs while they are being cross-cut into shorter lengths. (Gen.)

Steam feed. A long cylinder with a piston which is attached to the rear end of the carriage and draws the latter back and forth. (Gen.)
Syn.: shot-gun feed.

Steam hauler. A geared locomotive used to haul loaded logging sleds over an ice road. It is equipped with a spiked metal belt which runs over sprocket wheels replacing the driving wheels, and is guided by a sled, turned by a steering wheel, upon which the front end rests. (N. F.)

Steam jammer. *See* Steam loader.

Steam kicker. *See* Log stop and loader.

Steam loader. A machine operated by steam and used for loading logs upon cars. (Gen.)
Syn.: loader, steam jammer.

Steam log turner. *See* Log turner; Steam nigger.

Steam nigger. A long-toothed lever arm, actuated by steam pistons, which is used to turn logs on a sawmill carriage. (Gen.) *See* Friction nigger.
Syn.: nigger, steam log turner, log turner.

Steam skidder. *See* Skidder.

Steel crew. The crew which lays and takes up railroad track. (Gen.)

Stem winder. *See* Corkscrew.

Stepping, *n.* 1. Lumber worked to a size and pattern suitable for steps.
2. An export grade of southern yellow pine and Douglas fir.

Stick, *v.* To place lumber in a pile with stickers separating each course of lumber. (Gen.)
Syn.: pile, stack, strip.

Sticker, *n.* 1. A piece of lumber which separates the different courses of lumber in a pile. (Gen.)
Syn.: gobb, (E. C.), piling strip, strip.
2. A machine used in a sash, door, and blind factory for shaping door and sash rails and stiles, sash bars, and muntins. (Gen.)

Stillwater. That part of a stream having such slight fall that no current is apparent. (Gen.)
Syn.: deadwater.
Ant.: quickwater.

Stock, *n.* The handle of a cant hook peavey. (App.)

Stock boards. Boards of even widths, usually in widths of 8, 10, and 12 inches. (Gen.)

Stock logs, to. To deliver logs from stump to mill or railroads. (S. F.)

Stock widths. Lumber cut in even widths from 4 to 12 inches. (Gen.)

Stog, *v.* *See* Chink.

Storage boom. A strong boom used to hold logs in storage at a sawmill, booming grounds, or wherever necessary. (Gen.)
Syn.: holding boom, receiving boom.

Stow logs, to. In rafting, to place logs together and parallel within boom sticks which mark the outside of the raft section. (P. C. F.)

Straight grain. The wood of a tree or log is said to be straight grained when the principal wood cells are parallel to the axis of growth. A piece of lumber is said to be straight grained when the principal wood cells are parallel to its length.

Straight line. The direct attachment of a pulling cable from a donkey engine to a log without the use of block and tackle. (P. C. F.)

Straw boss, *n.* 1. A subforeman in a logging camp. (N. W., L. S.)
Syn.: head push.
2. A subforeman in a sawmill or a sawmill yard. (P. C. F.)

Stray. 1. A marked log passing through the sorting gap of a boom company and about the disposition of which there have been no instructions given. (L. S.)
2. A log which has passed the mill where it should have been taken from the water. (N. F., E. C.)
3. *See* Prize log.

Straw line. In power skidding, a small cable which is used in changing the skidding lines from one run to another. (P. C. F.)
Syn.: grass line.

Streak, *n.* (Turp.) The incision made when a tree is chipped. (S. F.)

Stream jam. *See* Center jam.

Stretcher. *See* Spreader.

String Measure. *See* Hoppus String Measure; Liverpool String Measure.

Stringer road. 1. *See* Fore-and-aft road.
2. A tram road with sawed wooden rails, used for hauling logs. (App.)

Strip, *n.* (Lum.) 1. A narrow 1-inch board. (Gen.)
2. *See* Sticker.
(Log.) An area of timber designated to be cut by a tie backer. (R. M. F.)

Strip, *v.* (Log.) To mark off strips for tie hackers. (R. M. F.)
(Lum.) *See* Stick.

Strip catcher, *n.* *See* Edger tailer.

Strip count. In surfaced lumber, a tally of pieces according to the width and length of the rough material from which the finished product was made. (Gen.) *See* Face count.

Strip road. In a cross-tie operation, a road cut out by the tie hacker on a given strip so that the haulers can reach the ties. (R. M. F.)

Strips. *See* Edgings.

Stub. *See* Snag.

Stud, *n.* *See* Scantling.

Studding, *n.* *See* Scantling.

Stull, *n.* A timber used in a mine to support the sides and roofs of the passages. (Gen.) *See* Mine prop; Prop.

Stumpage, *n.* The value of timber as it stands uncut in the woods; or, in a general sense, the standing timber itself. (Gen.)

Stump roller. *See* Road roller.

Stump spool. *See* Road roller.

Stump spud. A tool with a crowbar point on one end and a small spool-like shovel on the other end, used in digging holes under stumps, preparatory to placing a blasting charge. (P. C. F.)
Syn.: spud.

Sulky. *See* Logging wheels.

Superficial foot. (S. F.) *See* Surface measure.

Surface, *v.* To plane one or more sides of a board, plank, timber, or other sawed material. (Gen.)
Syn.: dress, plane.

Surface Measure. (S. M.) The area in square feet on one face of a board. When the boards are 1 inch in thickness the term is synonymous with board feet. (Gen.)
Syn.: face measure, superficial foot.

Surfacer, *n.* A general term for a machine which surfaces lumber. (Gen.)

S 1 S 1 E. A term used to designate lumber which has been surfaced on one side and one edge. The same system is used to designate lumber which has been surfaced on a greater number of sides; e. g., S 4 S designates a board surfaced on four sides. (Gen.)

S 4 S C S. Surfaced four sides with a calking seam on each edge. (P. C. F.)

Survey, *v.* *See* Grade.

Surveyor, *n.* 1. A State official who inspects and tallies cargo lots of lumber. (Gen.)
2. *See* Marker.

Swage, *n.* A tool used to spread the points of teeth of a band or circular rip saw. (Gen.)
Syn.: jumper, upset.

Swage a saw, to. To spread the ends of the teeth of a band or circular rip saw. (Gen.)
Syn.: square dress, to.

Swage set. A saw is swage set when the ends of the teeth are spread to a width greater than the thickness of the saw. Head saws and nearly all rip saws are swage set. (Gen.)
Syn.: square dress.

Swamp, *v.* To clear the ground of underbrush, fallen trees, and other obstructions preparatory to constructing a logging road, opening out a gutter road, skidding with animals, or yarding with a donkey engine. (Gen.)

Swamper, *n.* (Log.) 1. One who swamps. (Gen.)
Syn.: beaver, busher, gutterman. (N. F.)
2. One who walks behind a horse truck loaded with logs and applies the brake. (Cal.)
3. *See* Gopher.
4. *See* Chore boy.
(Lum.) *See* Off-bearer.

Swamp hook. A large, single hook on the end of a chain, used in handling logs, in skidding and in loading with a cross haul. (Gen.)
Syn.: jam hook. (N. W.)

Sway bar. 1. A strong bar or pole, two of which couple and hold in position the front and rear bunks of a logging sled. They are provided with a knuckle joint which permits the bunks to be jackknifed when the sleds are traveling empty. (N. F.)
Syn.: side pole.
2. The bar used to couple together two logging cars. (Gen.)

Sweep, *n.* The natural crook in a log. (Gen.)

Sweeps, *n.* Trees overhanging a stream which impede log driving. (E. C.)

Sweep the rear, to. *See* Sack the rear, to.

Swell butted. As applied to a tree, greatly enlarged at the base. (Gen.)
Syn.: bottle butted, churn butted.

Swifter, *n.* 1. Logs which are placed across the end of a raft section in order to prevent the logs in the raft from having too much play. (P. C. F.)
2. A rope or cable placed across the end of the first tier of each raft section in order to hold the boom sticks in position. Swifters are unnecessary where there are permanent booms to hold the raft sticks in place. (P. C. F.)
Syn.: cinch line.

Swing, *v.* *See* Gun.

Swig dingle. A single sled with wood-shod runners and a tongue with lateral play, used in hauling logs down steep slopes on bare ground. (N. F.)
Syn.: loose-tongued sloop.

Swing donkey. A donkey engine stationed between the yarding engine and the road engine on a long road or chute. (P. C. F.)

Swing saw. A circular cut-off saw the frame of which is suspended on a shaft either above or below the cutting line. The saw is pulled forward to make a cut and when released automatically retires from the saw cut. (Gen.)

Swing team. In a logging team of six, the pair between the leaders and the butt team. (P. C. F.) *See* Swing yoke.

Swing-up saw. A circular cut-off saw the frame of which is hung on a shaft blow the cutting line. The saw is swung up out of its housing when in use. Chiefly used to cut large timbers. (Gen.)

Swing yoke. In an ox team of three or more yoke, the pairs between the leaders and the wheelers. (App., S. F.) *See* Swing team.

Tag line. In yarding with a donkey engine, an extra cable used for various purposes. It may serve as an extension to the main cable in order to reach logs beyond the range of the pulling line; also it may be used to attach a block to a log or serve some similar purpose. (P. C. F.)

Tail chain. A brake consisting of a heavy chain bound around the trailing end of logs, used to check the speed of sleds on steep slopes. (N. W.)

Taildown, to. To roll logs on a skidway to a point on the skids where they can be easily reached by the loading crew. (N. F.)
Syn.: tailin. (S. F.)

Tail edger. *See* Edger tailer.

Tail end. *See* Rear.

Tailer-in, *n.* One who tails down for a loading crew. (S. F.)
Syn.: roll-down man. (S. F.)

Tail grab. *See* Single coupler.

Tail hold. 1. The attachment of the end of the pulling line to a stump or other stationary object, when tackle is used to increase the pulling power. (P. C. F.)
2. The block at the extreme point of the haul-back. (Cal.)
3. The attachment of the rear end of a donkey sled usually to a tree or stump. (P. C. F.)

Tail hook. *See* Dog.

Tailin, to. *See* Taildown.

Tail sawyer. *See* Log roller; Off-bearer.

Tail tree. In power skidding, a tree at the end of a run to which the tackle is fastened. (S. F., P. C. F.)

Take-away man. *See* Off-bearer.

Takoma. *See* Roader.

Tally, *n.* A record of the number of pieces and the grades of lumber. (Gen.)

Tally board. A thin, smooth board used by a scaler on which to record the number or volume of logs. (Gen.)

Tally card. *See* Tally sheet.

Tallyman, *n.* (Log.) One who records or tallies the measurements of logs as they are called by the scaler. (N. F.)
(Lum.) One who records on a tally sheet the number and grade of the pieces of lumber as they leave the sawmill. (Gen.) *See* Checker.

Tally sheet. A card or sheet of paper on which is recorded the number of pieces and the grades of lumber. (Gen.)
Syn.: tally card.

T. and G. Tongued and grooved. (Gen.)

Tank, *n.* *See* Sprinkler.

Tank conductor. One who has charge of the crew which operates a sprinkler or tank, and who regulates the flow of water, in icing logging roads. (N. F.)

Tank heater. A sheet-iron cylinder extending through a tank or sprinkler, in which a fire is kept to prevent the water in the tank from freezing while icing logging roads in extremely cold weather. (N. F.)

Tanking. The act of hauling water in a tank, to ice a logging road. (N. F.)

Taper set lever. A lever attached to the knee of a sawmill carriage head block by means of which any knee may be placed out of alignment. It is of service when making the first cuts on swell-butted logs. (Gen.)

Tap line. A chartered logging railroad which shares with the trunk line railroads in a division of the through lumber rate to market, on products originating at the plant of the owners of the logging railroad. (S. F.)

T. B. and S. In box shook manufacture, top, bottom and sides. (Gen.)

Team boss. One who has charge of the skidding teams in a logging operation. (S. F.)
Syn.: captain.

Tee, *n.* A strip of iron about 6 inches long with a hole in the center, to which a short chain is attached; it is passed through a hole in a gate plank, turned crosswise, and so used to hold the plank when tripped in a splash dam. (N. W.)
Syn.: toggle. (R. M. F.)

Tension, *v.* To make a circular or a band saw more loose in the center than on the cutting edge.
Syn.: open.

Thousand legs. *See* Corkscrew.

Three-block hold. *See* Block hold.

Three-ply veneer. A piece of built-up veneer composed of three pieces glued one to the other. *See* Laminated wood.

Three-year old, *a.* *See* Pulling.

Throat, *n.* On a saw, the rounded cavity in which sawdust accumulates and is carried from the cut. (Gen.)
Syn.: chamber, gullet.

Throw, *v.* *See* Wedge a tree, to.

Throw line. *See* Trip line.

Throw out. *See* Frog.

Tide, *n.* A freshet. In the Appalachian region logs are rolled into a stream and a "tide" awaited to carry them to the boom. (App.)

Tie chopper. *See* Tie hacker.

Tie cutter. *See* Tie hacker.

Tie hack. *See* Tie hacker.

Tie maker. *See* Tie hacker.

Tie man, *n.* At a sawmill plant, one who ties surfaced lumber, lath, or other products into bundles. (Gen.)
See lath bundler. (Gen.)

Tier, *n.* In rafting, the group of parallel logs which are stowed in each raft section. (P. C. F.)

Tight cooperage. Packages, consisting of two round heads and a body composed of numerous staves held together with hoops, which are used as containers for liquids. (Gen.)

Tight knot. *See* Standard knot.

Timber, *n.* (Log.) 1. A term which may have any of the following meanings: wood suitable for building houses and ships, and for use in carpentry and joinery; trees cut down and squared or capable of being squared or cut into beams, rafters, boards, etc.; growing trees suitable for constructive purposes; trees generally; woods or a single piece of wood, whether suitable for use or already in construction; the body, stem, or trunk of a tree. The meaning to be given to the term depends upon the connection in which it is used and sometimes upon the occupation of the person who uses the term. (Supreme Court of Georgia, 52 Southeastern Reporter, 324.)

2. A term which has a restricted meaning depending on the connection in which it is employed. It may refer to standing trees or stems, or trunks of trees cut and shaped for use in the erection of buildings or other structures and not manufactured into lumber, within the ordinary meaning of "lumber." It does not ordinarily refer to the articles manufactured therefrom, such as shingles, lath, fence rails, railroad ties, etc. (Supreme Court of North Carolina, 82 Southeastern, 1036.)

(Lum.) 1. Sawed material, 4 by 4 inches or more in dimension. (Gen.)

2. Sawed material more than 4½ inches in thickness and more than 6 inches in width. (English markets.)

Timber beast. *See* Lumberjack.

Timber carrier. *See* Lughooks.

Timber compass. *See* Gun.

Timber contract. *See* Timber right.

Timber dock. *See* Dock.

Timber grapple. *See* Lug hooks.

Timber mill. 1. A sawmill which specializes on heavy timbers. (Gen.)

2. In a sawmill, the sawing rig used for cutting timbers. (Gen.)

Timber planer. *See* Sizer.

Timber plugger. One who surreptitiously plugs knot holes and bad knots, especially on spar timber. (S. F.)

Timber right. A term used to denote the purchase of standing timber, without the acquisition of title to the land. (Gen.)

Syn.: timber contract.

Timber roller. *See* Dolly.

Timber wheels. *See* Logging wheels.

Tin, *n.* *See* Apron.

Tire, *n.* That part of a band saw blade, extending an inch or so back from the thoats, which has not been stretched to conform to the segment to which the balance of the blade is tensioned. This leaves the saw tighter at the tire than it is in the middle. The width of the tire varies with the width of the saw blade and the amount of tension carried. (Gen.)

Toe piling. Sharpened poles or timbers which are driven next to the up-stream face of the mudsills of a dam to prevent water from getting under the foundations. (Gen.)

Syn.: toe spiling.

Toe ring. The heavy ring or ferrule on the end of a cant hook. It has a lip on the lower edge to prevent slipping when the log is grasped. (Gen.)

Toe spiling. *See* Toe piling.

Toggle, *n.* *See* Toe.

Toggle chain. 1. A short chain with a ring at one end and a toggle hook and a ring at the other, fastened to the sway bar or bunk of a logging sled and used to regulate the length of a binding chain. (N. F.)

Syn.: bunk chain.

2. *See* Boom chain.

Toggle hook. A grab hook with a long shank, used on a toggle chain. (N. F.)

Tombstone, *n.* A slab torn from the bole, which adheres to the stump when a tree is felled. (S. F.)

Tommy Moore. *See* Bull block.

Ton, *n.* In reference to European timber measurement, 480 feet board measure.

Tong, *v.* To handle logs with skidding tongs. (N. F.)

Tong hooker 1. One who places the skidding tongs or chokers on logs which are being skidded by power or hauled on high-wheeled carts. (S. F.)
2. *See* Ground loader.

Tong puller. *See* Ground loader.

Tong unhooker. One stationed near the power skidder who releases the skidding tongs or removes the chokers from logs which have been drawn alongside the railroad. (S. F.)

Top bind chains. *See* Top chains.

Top chains. Chains used to secure the upper tiers of a load of logs after the capacity of the regular binding chains has been filled. (Gen.)
Syn.: top bind chains. (S. F.)

Top load. A load of logs piled more than one tier high, as distinguished from a bunk load. (Gen.)

Top loader. That member of a loading crew who stands on top of a load and places logs as they are sent up. (Gen.) *See* Head loader.
Syn.: sky hooker. (N. F.)

Top-lop, *v.* *See* Lop.

Top saw. The upper of two circular saws on a head saw, both hung on the same husk. Circular mills frequently do not have a top saw. (Gen.)
Syn.: double circular mill, overhead saw.

Top-sawyer, *n.* One who stands above the log and aids in operating a whip saw. (Gen.)

Torn grain. A machine defect on surfaced lumber, the fibres of the wood having been torn out around knots and curly places by the action of the planer knives. It is classified as slight, one-thirty-second inch deep; medium, one-sixteenth inch deep; heavy, one-eighth inch deep; and deep, more than one-eighth inch deep. (Gen.)

Tote, *v.* To haul supplies to a logging camp. (N. F.)

Tote road. A road used for hauling supplies to a logging camp. (N. F.)
Syn.: fly road, hay road.

Tote sled. *See* Jumper.

Tow team. An extra team stationed at an incline in a logging road to assist the regular teams in ascending with loaded sleds. (N. F.)
Syn.: snatch team.

Track cable. *See* Skyline.

Track line. *See* Skyline.

Traction, *n.* An oil burning or a gasoline traction engine used in hauling log trucks. (Cal.)

Trail, *n.* 1. *See* Turn.
2. The path traveled by a team when trailing logs in a chute. (R. M. F.)

Trail, *v.* *See* Jigger.

Trail chute. *See* Trailing slide.

Trail dogs. *See* Grapples.

Trailers, *n.* Several logging sleds hitched one behind another and pulled by from 4 to 8 horses driven by one man, thus saving teamster's wages; also applied to sleds or wagons drawn by a steam or gasoline log hauler. (N. F., E. C.)

Trailing slide. A slide on which the grade is so low that animals are required to move the logs. (App.)
Syn.: trail chute. (R. M. F.)

Trail slide. An earth skidding trail, reenforced on the lower side by a fender skid. (App.)

Train, *n.* (Lum.) In fluming lumber, a number of bundles of lumber tied together end to end. (Cal.)
(Log.) *See* Turn.

Tram, *n.* *See* Tramway.

Tram, *v.* To transport lumber from the sawmill to the drying yard. *See* Distribute lumber, to.

Tramway, *n.* A light or temporary railroad for the transportation of logs, often with wooden rails and operated by horsepower. (Gen.)
Syn.: tram.

Transit car. A shipment of lumber leaving the mill either unsold or with final destination not determined. (Gen.)

Trap boom. *See* Catch boom.

Trash, *n.* *See* Dross.

Travois, *n.* *See* Go-devil.

Travois road. *See* Skid road.

Tray shakes. Shakes that are used as bottoms for trays in drying fruit. They are usually 24 inches long, 6 inches wide, and one-fourth inch thick on the thinner edge. (Cal.)

Trim, *n.* *See* Interior trim.

Trim, *v.* To make square the ends of boards and timbers. (Gen.)
Syn.: butt, clip, end butt, equalize.

Trimmer, *n.* A battery of cut-off saws, either suspended from above the trimmer table or hung beneath it, which is used to trim the ends of lumber to even lengths. (Gen.) *See* Overhead trimmer.
Syn.: equalizer.

Trimmer feeder. *See* Trimmer loader.

Trimmer leverman. One who operates the levers by means of which the trimmer saws are raised and lowered. (Gen.)
Syn.: trimmer man.

Trimmer loader. One who stands at the trimmer and places the lumber in position on the table in front of the trimmer saws. (Gen.)
Syn.: trimmer feeder (P. C. F.), trimmer setter.

Trimmer man. *See* Trimmer leverman.

Trimmer setter. *See* Trimmer loader.

Trip. (Lum.) *See* Lumber transfer.
(Log.) *See* Turn.

Trip, *v.* *See* Wedge a tree, to.

Trip a dam, to. To remove the plank which closes a splash dam. (N. F.)

Trip line. 1. A light rope attached to a dog hook, used to free the latter when employed in breaking a jam, a skidway or a load. (N. F.)
Syn.: throw line.
2. *See* Haul back.

Tripper, *n.* One who, by means of mechanical or other devices, diverts lumber from live rolls behind the saw to the edger or to some other machine. (Gen.)
Syn.: pointer (Cal.), edger helper, tripper man. (Gen.)

Tripper man. *See* Tripper.

Tripsill, *n.* A timber placed across the bottom of the sluiceway in a splash dam, against which rest the planks by which the dam is closed. (Gen.)

Trolley, *n.* (Log.) A traveling block, used on a cable in steam skidding. (S. F., P. C. F.)
Syn.: bicycle, carriage (S. F., P. C. F.), buggy (Cal.).
(Lum.) A small iron-wheeled car running on a wooden track, which hauls lumber from a portable sawmill to the storage yard. (N. F.)
Syn.: buggy.

Trough roof. A roof on a logging camp or barn, made of small logs split lengthwise, hollowed into troughs and laid from ridgepole to eaves. The joints of the lower tier are covered by inverted troughs. (N. F.)
Syn.: shake roof.

Truck, *n.* 1. A heavy wagon used to haul logs, either with animal or power traction. (Gen.)
2. *See* Logging truck.

Truck driver. A teamster who skids logs with a bummer. (S. F.)

Trucker, *n.* One who handles rough lumber from the dry sheds or yards to the planing mill. (Gen.)

Tump line. Two leather straps sewed or buckled to a leather head strap about four inches wide, and used to carry packs. (E. C.)

Turkey, *n.* A bag containing a lumberjack's outfit. To "histe the turkey" is to take one's personal belongings and leave camp. (N. W., L. S.)
See Duffle bag.

Turn, *n.* 1. A single trip and return made by one team in hauling logs—*e. g.*, a four-turn road is a road the length of which will permit of only four round trips per day. (N. F.)
Syn.: trip. (Gen.)
2. Two or more logs coupled together end to end for hauling. (P. C. F.)
Syn.: trail, train.

Turn, *v.* (Turp.) To change from chipping to pulling. (S. F.)

Turn-around, *n.* A cleared area, surrounding a bunched pile of logs, in which logging wheels turn. (Texas.)

Turner. *See* Log roller.

Turn out, to, *v.* (Turp.) To temporarily or permanently abandon an area for turpentine purposes. (S. F.)

Turpentine, *n.* The liquid product resulting from the distillation of crude turpentine. (Gen.)
Syn.: spirits.

Turpentine ax. A long-bitted ax used in cutting a box. (S. F.)
Syn.: boxing ax.

Turpentine orchard. A stand of pine which is being bled for crude turpentine. (S. F.)
Syn.: farm, place.

Twin band mill. A mill that has both a right-hand and a left-hand saw used to slab logs or to rip cants. Both saws may be mounted on the same frame or they may be mounted on separate movable frames, so that the distance between saws may be altered. (Gen.)

Twin sled. *See* Logging sled.

Twister, *n.* 1. *See* Spanish windlass.
2. *See* Camp foreman.

Twitch, *v.* *See* Skid.

Two-block hold. *See* Block hold.

Two-faced tie. A pole tie with only two hewed faces. It is made from a stick of timber too small to hew four sides. (S. F.)

Two sled. *See* Logging sled.

Undercut hold. A method of arranging the choker on a log so that when a forward pull is exerted the log will roll backward. (P. C. F.)
Syn.: underhold roll.

Undercut, *n.* The notch cut in a tree to govern the direction in which the tree is to fall and to prevent splitting. (Gen.)
Syn.: notch (Gen.), box (N. F.), nick (S. F.).

Undercut, *v.* *See* Notch.

Undercutter, *n.* 1. A skilled woodsman who chops the undercut in trees so that they shall fall in the proper direction. (Gen.)
2. A tool used to support the back of a cross-cut saw when a bucker is making a cut from the under side of a log. (P. C. F.)

Undercut trimmer. A trimmer, the saws of which are hung below the trimmer table, cutting from the underside of the board. (Gen.)

Underhold roll. *See* Undercant hold.

Underweights. The difference between the association standard and actual rail shipping weights of shingles and lumber. These products are sold on the association standard shipping weights. By kiln-drying, shippers are able to reduce the actual shipping weight below the standard and thus profit by the difference in the freight charges. (Gen.)

Union drive. A drive of logs belonging to several owners, who share the expense *pro rata*. (N. F.)

Upright roller. *See* Road roller.

U/S. (Unsorted.) A term used in European lumber trade quotations.

Unstacker. One who removes dry lumber from dry-kiln trucks. (Gen.)

Uppers, *n.* *See* Finish.

Upset, *n.* *See* Swage.

Value, *v.* *See* Cruise.

Valuer, *n.* *See* Cruiser.

Van, *n.* 1. The small store in a logging camp in which clothing, tobacco, and medicine are kept to supply the crew. (N. W., L. S.) *See* Commissary.
2. Clothing and small ware supplied to woodsmen. (E. C.)

Veneer, *n.* A thin piece of lumber cut on a veneer machine. There are three kinds of veneers, namely, sawed, sliced, and rotary cut. (Gen.)

Vertical band resaw. *See* Horizontal band resaw.

Vertical-grained. *See* Quarter-sawed.

Virgin, *a.* (Turp.) A term applied to a box or cup during the first season the tree is bled. (S. F.)

Virgin dip. (Turp.) The crude turpentine secured during the first year a tree is bled. (S. F.)

Wagon box boards. Lumber used in the manufacture of wagon box sides. (Gen.)
Syn.: box boards.

Wagon sled. *See* Logging sled.

Wane, *n.* Bark or the lack of bark or a decrease in wood from any cause on the edge of a board, plank, or timber. (Gen.)

Waney lumber. Lumber which is not square edged.

Wanigan, *n.* A houseboat used as sleeping quarters or as kitchen and dining-room by river drivers. (N. W., L. S.)

Warp, *v.* To tow a boom of logs with a headworks or alligator.
Syn.: kedge.

Washboard, *v.* In sawmilling, a term used to denote the action of a saw which makes ridges on lumber. (Gen.)

Waste, *n.* (Log.) On a logging operation, that portion of the tree which has merchantable value, but is not utilized. The standard varies with the species, location of the timber, and market conditions. (Gen.)
(Lum.) Waste at a sawmill is that portion of the log having a merchantable value which is not utilized. Sawdust and refuse used for fuel, and those

portions of logs, slabs, edgings, and trimmings used for laths, shingles, cooperage, and other products are not waste. (Gen.)

Water box. *See* Sprinkler.

Water buck. One who packs water, either for a logging crew or for a donkey engine. (Cal.)

Water ladder. Pole guides, up and down which a barrel slides in filling a sprinkler by horse-power. (N. W., L. S.)

Water slide. *See* Flume.

Water stain. Streaks or patches of red or brown discoloration in firm wood of hemlock.

Water streak. A dark streak in oak lumber due to injury to the standing timber. (App.)

Wavy grain. *See* Curly grain.

Weather board. *See* Bevel siding; Siding.

Weaver's bind. A method of binding chains around logs on a dray. (N. W.)

Wedge a tree, to. To topple over with wedges a tree that is being felled. (Gen.)

Syn.: throw, trip.

Weed, *v.* *See* Rake.

Well, *n.* A hole dug in the snow surrounding a tree, in order that the chopper may cut the tree at the required height. (R. M. F.)

Wet mill. A sawmill at which logs are stored in water. (Gen.)

Wet slide. *See* Flume.

Wheel camp. 1. An operation in which the logs are transported to the skidways on logging wheels. (Cal.)

2. A camp, the quarters of which are mounted on railroad trucks. (P. C. F.)

Wheelers, *n.* In a team, the pair next to the load. (App., E. C., S. F.) *See* Snub yoke.

Syn.: butt team.

Wheel jointer. *See* Lister.

Whiffletree neck-yoke. A heavy logging neck-yoke, to the ends of which short whiffletrees are attached by rings. From the ends of the whiffletrees wide straps run to the breeching, thus giving the team added power in holding back loads on steep slopes. (N. F.)

Whip-poor-will, *n.* A small log fastened diagonally across a log slide and used to shunt logs onto a dump. (App.)

Syn.: jumper.

Whip-saw, *n.* A saw, operated by two men, which is used to cut logs into lumber. (Gen.)

Syn.: pit-saw.

Whip-saw, *v.* To cut lumber with a whip-saw. (Gen.)

Whistle boy. One who transmits orders from the foreman of a skidding crew to the engineer of a pullboat. (S. F.)

Whistle punk. *See* Signal man.

White cypress. (Log.) A term used by woodsmen for cypress timber of light weight. (S. F.)

(Lum.) A term used by lumber manufacturers to denote cypress lumber which is light in color. (S. F.)

White water. *See* Quick water.

White-water man. A log driver who is expert in breaking jams on rapids or falls. (N. F.)

Wholesale lumber dealer. One who buys lumber outright and takes all profits from sales.

Widow maker. 1. A broken limb hanging loose in the top of a tree, which in its fall may injure a man below (N. F.); or a breaking cable (P. C. F.).
Syn: leadman. (N. W.)
2. A tree which in falling is lodged in the top of another. (App.)

Wigwam, to make a. In felling trees, to lodge several in such a way that they support each other. (N. F.)

Windfall, *n.* An area upon which the trees have been thrown by wind; also, a single tree thrown by wind. (Gen.)
Syn.: blow down, wind slash. (N. F.)

Windshake, *n.* *See* Shake.

Wind slash. *See* Windfall.

Wind splitter. *See* Peaker.

Wing dam. *See* Pier dam.

Wing jam. A jam which is formed against an obstacle in the stream and slants upstream until the upper end rests solidly against one shore, with an open channel for the passage of logs on the opposite side. (N. F.)

Wire a car, to. In loading a flat car, to fasten together opposite car stakes with wire. (Gen.)

Wobble saw. A thin circular saw of small diameter firmly set at an angle on a mandrel and used to cut grooves in wood. Its object is to remove a wide kerf and obviate the necessity of using several saws. Largely becoming obsolete, due to the development of the dado-head saw. (Gen.)

Woodboat, *n.* A single sled with two skids attached by their forward ends to the bunk, and with their rear ends dragging, which is used to haul cordwood off of steep or rocky slopes. (N. W.)

Wood buck. *See* Wood bucker.

Wood bucker. One who cuts wood for a donkey, road engine, or other power skidding device. (P. C. F., R. M. F.)
Syn.: wood buck.

Wood fibre. A substitute for hair in plaster, consisting of narrow shavings cut from a round block of wood by means of a special machine. (Gen.)

Woodhick. *See* Lumberjack.

Wood passer. One who transports wood fuel in a flatboat from the cutting point to a pullboat. (S. F.)

Woodpecker, *n.* A poor chopper. (Gen.)
Syn.: beaver. (N. W.)

Woods foreman. *See* Woodsrider.

Woodsrider, *n.* (Turp.) One who has charge of the operation of the whole or a part of a turpentine orchard. (S. F.)
Syn.: woodsman, woods foreman.

Wood-wool, *n.* Fine shavings made from wood and used as a substitute for hair in plaster and when made from pine and specially prepared sometimes used as a surgical dressing. (Gen.)

Worm roller. *See* Screw rollers.

Wrapper chain. *See* Binding chain.

Yankee gang mill. An early and obsolete type of gang mill in which the sash consisted of two parts, one holding saws for removing slabs, and the other having saws designed to cut cants into lumber. The two processes were carried on simultaneously, the log passing through one side of the sash from the front and a cant returning through the opposite side of the sash from the rear.

Yard, *n.* *See* Skidway; Landing.

Yard, *v.* *See* Skid; Rank.

Yarding donkey. A donkey engine mounted upon a heavy sled, used in yarding logs by drum and cable. It hauls logs from the stump to a skidroad or to a landing; for short distances only. *See* Half-breed; Roader; Donkey.

Yarding hook tender. *See* Hook tender.

Yarding sled. *See* Dray.

Yarding spool. *See* Road roller.

Yard lumber. Lumber which has been air-dried in a yard. A term often applied collectively to those grades of lumber usually air-dried. (Gen.)

Yard tender. *See* Decker.

Yearling, *a.* (Turp.) A term applied to a box or cup during the second season the tree is bled. (S. F.)

Yoke, *n.* The heavy U-shaped part of a block by which the block is attached to an object. (Gen.)

Syn.: gooseneck, shackle.

OUR PRESENT KNOWLEDGE OF THE FOREST FORMATIONS OF THE ISTHMUS OF PANAMA[1]

By Dr. H. Pittier

This is a brief account of some results of the study of the flora of Panama made in connection with the general biological survey organized by the Smithsonian Institution.

When, in 1910, I started the systematic botanical exploration of the country, about 1,115 species had already been catalogued, due mainly to the efforts of Seemann, Hayes, Fendler, and a few others. Of these plants, nearly four-fifths had been collected along the transisthmian railway, at the mouth of the Chagres River, around the city of Panama, and in the savanna and park-like formations along the Pacific coast. From 1910 to 1912 and in 1914 the survey was extended over the whole Isthmus, excepting the stretch of the coast between Colon and the Almirante Bay. A little over half of the collections made have been worked up and about 3,000 species have been listed. It is expected that after all the materials brought together have been examined the total number of known species will reach far above 3,500. This is about 2,500 less than the number of species recorded for the neighboring Costa Rica, but this large difference is easily explained by the fact that while the territory of the latter country is distributed in fair proportions between the sealevel and an altitude of nearly 3,900 meters, nearly nine-tenths of the Isthmus is included in an altitudinal belt of less than 1,000 meters.

Six-tenths, at least, of the territory of Panama is covered with forests, while the rest is given to savannas, park-like formations, and the very small openings resulting from human activity. Leaving the latter aside, the respective distribution of the natural formations, forests, savannas, and park-like landscapes is the result mainly of the régime of the rainfall, dependent itself on the dominating winds.

As is well known, the Isthmus of Panama stretches in a west-easterly direction between the Caribbean Sea and the Pacific Ocean, and is thus fully exposed on one side to the northeast trade-wind, on the other to the southwest monsoon. Both these atmospherical currents reach the respective coast saturated with humidity, which is dropped as they

[1] Read to the Biological Society of Washington, November 18, 1916.

ascend the slopes. The trade-wind reaches its maximal intensity when the sun is farthest south of the Equator, in March, and is prevailing on the Isthmus during about nine out of twelve months, making its influence felt clear across the country. The monsoon, on the other hand, is very irregular, at least in the central and western sections of the Pacific coast, blowing with some constancy only from May to October and not strong enough, as a rule, to modify the climatic conditions on the Atlantic watershed.

Thus the trade-wind practically causes abundant and perennial rainfall on the northern seaboard of the country, but having lost most of its humidity in the ascent to the summit of the Continental Divide, it acts in the opposite way, that is to say, as a drought-producing wind, on the southern slope, with the exception of a narrow fringe of the upper belt. During the predominance of the monsoon, however, such effect of the trade-wind on the Pacific slope is overcome, and for nearly six months this slope is favored with almost daily rainfall. At the southernmost end of the country, in Darien, the monsoon blows stronger and with greater regularity, causing again abundant perennial rainfall, interrupted, however, by two short dry spells, in March-April and September-October. This district is adjacent with the Colombian Chocó, which shows the heaviest rainfall of the western continent.

To sum up, the climate of the Atlantic watershed and of Darien is characterized by the rainfall being distributed on the whole length of the year, while that of the central and western sections of the Pacific slope shows two well-marked periods—a dry season, lasting from December to April, and a wet season, extending between May and November.

Panama City has 180 days of annual rainfall; Colon, 246 days. The latter, however, is a low average, because of the exceptional location of Colon, in front of the great gap in the Continental Divide. Port Limon, in Costa Rica, has 304 days. The annual amount of rainfall is, of course, much larger on the Atlantic side: Colon has an average of 3.10 m. (129.4 inches), Panama only 1.80 m. (70.9 inches). No data are available as yet for Darien. The amount of rainfall decreases as the altitude increases: the dryest point in Panama is probably the summit of the Chiriqui Volcano, situated to the south of the Continental Divide.

These peculiarities in the régime of the winds and of the rainfall are sufficient to explain the presence of a continuous forest belt along the Atlantic seaboard, as well as in Darien and on both sides of the crest of the Continental Divide, and of savannas and park-like formations in the remaining part of the Pacific slope.

With regard to their specific composition, these forests are exceedingly varied and belong with very few exceptions to the type of mixed dicotyledonous forests. Up to the present we have listed about 900 species of trees, belonging to 330 genera and 90 families. This computation does not include shrubs and woody vines, which would materially increase the number of species and genera, if not that of families.

The order Leguminosæ is the dominating group, with 50 genera (Papilionatæ, 20; Cæsalpiniaceæ, 19; and Mimosaceæ, 11). Then follow the Rubiaceæ with 34, the Palms with about 24, Euphorbiaceæ with 17, Moraceæ with 14, and Myrtaceæ with 11 genera. Of the Rubiaceæ, it should be observed that only about 14 genera have the real tree-habit, and the larger number consists of ligneous shrubs with wide representation in the underbrush of all forests. The family is really the dominating one among the woody plants, with the exception perhaps of the genus Piper, which shows a considerable number of well defined but very much localized forms. Tree-ferns and bamboos do not form, as a rule, a conspicuous element of the Panaman forest.

Among the families with from 5 to 10 genera, the Lauraceæ (7) and Bignoniaceæ (9), are economically the most important, but others like Sapotaceæ (6), Guttiferæ (9), Bombacaceæ (10), Sapindaceæ (8), Combretaceæ (5), Anacardiaceæ (7), Anonaceæ (7), and Lecythidaceæ (6), also contribute in an effective way to the characterization of our forests. Numerous in genera and species, but mostly shrubs, are the Melastomataceæ, Myrsinaceæ, and Apocynaceæ, which play an important ecological rôle. Of the remaining families, 33 are represented by 1 genus only, and a few others by 2, 3, or 4 genera, mostly with few species each.

The Panaman forests belong almost entirely to primary formations, in which the primeval type is seen in all its glory. Secondary growth appears only in the neighborhood of human settlements and along the main trade routes. Though we are often offered descriptions of virgin wilderness by travelers who have ridden or tramped along the railroad from Colon to Panama, few if any of these writers have known what they were writing about. Virgin forest exists in close proximity of the Canal and Panama Railroad, only at a few places unfit for cultivation on account either of their being too swampy or too hilly, and they present there their most stunted type. The only exception, to my knowledge, was on a short stretch of the old railroad, between the Black Swamp and Gatun, where lies Lion Hill, the favorite hunting ground of many collectors. There, small patches of full-fledged primeval forests could still be seen a few years ago, but, with the exception of a few small islands, they are now lying at the bottom of the Gatun Lake. All that is seen today along the road is secondary growth, often of many years standing, but always characterized by the thick underbrush, the abundance of Cecropia, Urera, and other groups of the so-called tree-weeds, the relative absence of epiphytic plants, the climbing sedges (*Scleria*) with blades as sharp as a razor's, and the extensive fields of small or giant Heliconia.

The real primary forest is found usually in parts removed from roads or towns. It presents several types, according to the prevalence of rainy or semi-dry climate, and in each case subdivisions can be established on geological or topographical features, the latter including such factors as altitude and combined sometimes with others—exposure, change in temperature, etc.

On the Atlantic watershed and in the interior of Darien we have principally dicotyledonous rain-forests of the mesophytic type. Bamboo thickets are rarely met with; tree-ferns are scarce; palms, better represented perhaps in the southern district, are never conspicuous or dominating. This type of forest reaches its full development in the plain, as, for instance, on the alluvial flats of Darien. On the hills the humus layer is thinner, the humidity of the soil less, and the size of the trees somewhat reduced. Some of these, however, rooted on hilltops or on flat ridges, rival in size the giants of the plains. Such are, for instance, the enormous, small-leaved Monkeypot trees (*Lecythis*), which are seen towering above the forest on the hills around Puerto-Obaldia on the San Blas coast, or the Coumarouna trees of the foothills in the Sambú Valley (Darien). A Monkeypot tree which I had felled to obtain specimens near the place first mentioned measured 1.62 m. in diameter at the base; the trunk was 42 m. from the base to the crown and the approximate total height was 55 m., or about 175 feet. In all those tall trees the crown is umbrella-shape, with a single, terminal story of very large, radiating limbs. In the trees of lesser size, filling the space under the former, the crown is elongate, also with radiate arrangement of the branches, which, however, are disposed in several whorls. There is a great variety in the size and shape of the leaves, but as a rule they are narrow in proportion to their length and long tipped, and often pinnate or palmate; in many cases also they are bunched at the end of the branchlets, as, for instance, in the odd-looking Cespedesia seemanni, with long, nude black limbs ending in enormous bunches of obovate leaves about 1 m. long, from the middle of which issues a no less immense spare raceme of brilliant yellow flowers. Furthermore, in most trees of the evergreen rain-forest, the leaves are glabrous and more or less glossy, and they never become wet on the surface, strongly as the rain may pour. I think, however, I have noticed sometimes species which do not show this peculiarity.

Although the foliage, as a rule, is perennial, there are species of Lecythis, Sapium, Vitex, and some others, absolutely deprived of leaves at certain periods.

An interesting peculiarity of the rain forest is the frequence of cauliflorous trees, that is, of trees which produce their flowers on the old wood of the trunk and larger limbs. Cacao tree is a classical case. In the Panama forests there are several species of the same genus, Theobroma, with the same character, but also at least two species, one of which has been recently separated as a new genus (and is seen only in a state of semi-cultivation), which produce flowers both on old wood and slender branchlets, or only on the latter. Other cauliflorous species are the beautiful Brownea macrophylla, with heavy hanging clusters of purple flowers surrounded with broad scarlet bracts, Grias fendleri, discovered first by Fendler in the forest at the mouth of the Chagres River and found again by myself in Darien. In Gustavia nana a reduced raceme of large pink flowers appears on the trunk just above the ground; in G. superba, which belongs to another formation, numerous flowers, nearly two inches in diameter, cover the terminal part of the old wood, just under the large fasciculate leaves. In Quassia amara and Simaba cedron, as well as in several species of Talisia, slender racemes issue also from the old wood just beneath the bunched leaves. It also seems to me that the large floriferous branchlets of the several species of cannon-ball trees (*Couroupita*) should also be considered as belonging to cauliflorous species, this contrary to the opinion of several ecologists of authority; these branchlets issue from the trunk, they are leafless, and their status is evidently the same as that of any smaller inflorescence.

Another feature which is not special, but frequent in trees of the rain-forest, is the presence at the base of their trunks of plank-buttresses, which form the origin of the lateral roots and radiate around the trunk in variable numbers. These planks are 2 to 3 m. high and broad in certain giant fig-trees, and then the interval between them need only be roofed to form a very comfortable and well sheltered cell. In Sterculia they are equally high, but narrower; in Sloanea they are low and broad; in Dimorphandra they form an intricate wood-work; in Mimusops they are rounded and stout. Many species of trees can be distinguished by the appearance of their buttresses, and it seems that these are seen mostly in species growing on flat, soft ground, their object being probably to give the tree a broader base and firmer standing.

On many other characteristic features of the trees and shrubs of the rain-forest fragmentary information has been collected which may be used as a basis for further study; but while all are very instructive, these data are not sufficiently well defined and grounded to be presented at this time.

The arrangement of the trees of the rain-forest in successive tiers is a fact which easily strikes the student and has been commented upon by many authors. In the rain-forest of Darien, very tall trees, the crown of which spreads in full sunlight, are not numerous, and it is difficult to procure the necessary specimens for their identification. Besides one or two species of giant fig-trees, I have been able to recognize two of the principals and to describe them as new species: Couroupita darienensis, the Darien cannon-ball tree, and Coumarouna panamensis, a papilionate tree nearly related to the one producing the tonka bean. Of those forming the lower levels we have already a long list. The giant trees just named appear as islands above the general upper surface of the forests, so that the second story from above is really the principal one. As constituents of this level we note, among others, species of Copaifera, Virola, large-leaved Lecythis, Brosimum, Pourouma, and at least one tall palm; in the third or middle level there are species of Alseis, Warscewiczia, Guatteria, Eschweileria, Brownea, and an increasing number of palms; below this we enter into the dominion of shrubs, extremely rich in species, with predominance of Rubiaceæ, Piperaceæ, and Melastomataceæ, and again a few dwarf palms. The density of the underbrush and immediate covering of the soil is dependent upon the nature of the latter and the amount of light it receives; grasses and sedges are scarce; terrestrial Aroids appear in wet places; thickets of Heliconias and their allies on the richer river flats, while districts with a clayey soil covered with a thin layer of humus will be rendered almost inaccessible by continuous fields of Bromelia karatas, intermixed here and there with patches of the large toothed Ananas.

Add to this picture numerous vines, sometimes hanging in festoons from the lofty heights, sometimes stretching vertically like as many taut cables, and the luxurious vegetation of epiphytes, covering trunks, branchlets, and even leaves, and a general though imperfect idea of the rain-forests of Panama will have been evolved.

In the same way one going from the base to the summit of a mountain crosses all vegetation belts, passing gradually from the one to the other; the transition from the rain-forest of Darien or from the rain-forest of the Atlantic coast to the semi-dry forests of the Pacific proceeds step by step in steady but almost unnoticeable gradation. In Darien, the real lofty rain-forest is seen only in the hinterland and on the broad flats along the middle course of the Tuyra and Chucunaque rivers. The foot-hills have a different character, proper of a dryer climate, and which accentuates itself more and more as we approach the shores of the ocean. On the other hand, descending the great collecting artery of the region, the Tuyra River, we soon reach the tidal-belt and are not long in noticing a brusque transition in the character of the flora, the mixed forests of the interior being replaced by intensely gregarious formations. Thus, on the foot-hills, a slightly increasing altitude produces a marked but very gradual change, while a nearer approach to the low, periodically inundated coast flats is signalled by a brusque transformation in the character of the forest. In the first case, the passage is from the evergreen rain-forest to the semi-deciduous or monsoon-forest; in the second, we proceed by sharply defined stages toward the coastal mangrove formation.

As defined by Schimper, the monsoon-forest is characterized by "trees losing their hygrophilous foliage during the dry season and renewing it at or immediately before the commencement of the monsoon-rains; apart from this, they have only xerophilous organs well protected against drought." This definition applies adequately to a large part of the Panaman forests of the Pacific watershed with one or two dry seasons. The minimum of rainfall assigned to that formation is that of Panama City, 1.80 m. It is safe to assume that the amount gradually increases going eastward, and decreases in the opposite direction. We reckon as monsoon-forests those west and south of Panama City, while the dryer forests of Veraguas and Chiriquí have to be considered as true xerophilous woodland.

The typical, ever-prominent tree of the monsoon-forest of Darien and the eastern Pacific coast is the Cuipo-tree, *Cavanillesia platanifolia*, which reaches here the northernmost limit of its extension, while to the southward it goes as far as Peru. It is exceptionally abundant and certainly gregarious on the low hills of Darien, in the Canal Zone, and appears among the remnants of the primeval forests in pastures and old clearings. It is 40 to 50 m. high when fully grown, with a basal diameter of over 2 m. On top of a monumental columnar trunk there rests a scanty crown, so that when the tree is seen isolated it gives an odd impression of disproportion, like that of a very tall and broadshouldered man with a small head and a wingless hat. The bark is smooth and reddish and, like the Ceiba and certain Burseraceæ, it does not offer a convenient substratum for epiphytic vegetation.

Several other trees contribute to the formation of the upper story of the monsoon-forests, among them Enterolobium timbouva, which, in opposition to the congenerous Guanacaste, E. cyclocarpum, is a real forest tree; Pentaclethra filamentosa, an elegant Mimosaceous tree; a conspicuous species of the recently described genus Dilodendron, etc. But the following, lower story is exceedingly rich in beautiful types, mostly very much mixed and scattered, but also sometimes semi-gregarious. To be brief, I shall only mention, among the Leguminosæ, two species of Centrolobium, two of Pterocarpus, a Peltogyne with beautiful purple wood, Platymiscium polystachium, Platypodium maxonianum, several Dalbergias, among them Dalbergia retusa, the main source of the much discussed cocobola-wood of commerce; among the Anacardiaceæ, Spondias lutea and Anacardium rhinocarpus, which enterprising American firms tried to put on the San Francisco market as mahogany wood, but which proved to be too hard on tools on account of the silica crystals which fill its cells; several Sapotaceæ, Burseraceæ, and Rutaceæ, and among the Bignoniaceæ, jacaranda and Tecoma guayacan, both with gorgeous blossoms, respectively blue and yellow, and the latter with one of the hardest timbers of the tropics.

The space under the large trees, which rise to an average height of 25 to 30 m., is much more open than in the rain-forest. The epiphytic vegetation is also less developed, but the vines and trailers are more numerous and varied. To be noted, also, is the relative abundance of thorny vines and shrubs, and the presence of cespitose palms with slender stems and elegant bearing. Traveling through this type of forest is almost everywhere free and easy.

As we proceed from Panama westward the forest formation becomes more broken and at the same time assumes a more xerophilous character, without, however, ever assuming, as in the northern districts of Venezuela, the extreme case of an underbrush mixed with Cereus and Opuntia species. These woods belong to the type designated as savanna-forests and are better considered in connection with the study of the grass formations. At the extreme western end of Panama, the monsoon-forest appears again with a strongly modified composition as to its floristic elements, but with the same general characters.

We know very little as yet as to the change produced in the rain-forest of Panama by the increase in altitude and the correspondent depreciation in temperature. In the deciduous forests of the southern water-shed, especially on the slopes of the Chiriqui volcano, a gradual change is observed during the ascent, a group of families after another showing its predominance. At an altitude little above 1,000 m., in the Boquete Valley, Ulmus mexicana, Cedrela, Sapium, and Inga species are very common, but the Lauraceæ become more and more frequent with the progress toward the summit until some of its representatives form a real gregarious forest up to an altitude of about 2,500 m. Above this the evergreen oaks, which appear first in isolated clumps at a much lower altitude, form extensive groves up to the upper timber-line. The underbrush is never very heavy at high altitudes and strongly mixed with annual or suffruticose plants. Several epiphytes become terrestrial, and a nettle, Urtica irazuensis, forms in places extensive fields under the shade of the oaks. On the whole, the vegetation assumes here a subtropical or even more northern character. Toward the upper forest line, in the cool vales around the upper peak, there are clumps of forest almost exclusively formed of large, but stunted and spreading Escallonia, which I consider to be the *E. posana* of the Costa Rican Mountains.

SUMMARY OF THE WHITE-PINE BLISTER RUST SITUATION [1]

By Dr. Haven Metcalf

At the Albany meeting of this committee approximately one year ago, I stated, in summarizing the situation of that time, that we faced essentially three problems rather than one, the problem being different in three sections of the country, as follows:

1. West of the Mississippi River.—In this territory the disease was not known to occur, but was believed to have been carried in on nursery stock of 5-needle pine or Ribes. No effective quarantine for this section existed at that time.

2. From the Mississippi River to the Hudson River.—In this territory advance infections had been successfully stamped out in Ohio and Indiana. Serious local infections existed in Wisconsin and Minnesota, particularly in the territory within 30 miles of St. Paul. The disease was not known to be present in Michigan. It was known to exist scatteringly in western New York and Ontario, while the Niagara Peninsula in Ontario was seriously infected. Several infections, mostly in nurseries, had been found in Pennsylvania and New Jersey.

3. East of the Hudson River.—In this territory infection was general, particularly on Ribes, and there was no hope of completely eradicating the disease.

At the present time our territorial division of the problem still holds good. The States west of the Mississippi have been scouted; hundreds of potentially dangerous shipments of nursery stock of both 5-needle pines and Ribes have been found which will need to be watched for many years. So far, however, the disease has been found at only four points in the eastern part of this territory, namely, one nursery and one small planting in Minnesota, one small planting in northwestern Iowa, and one small planting in eastern South Dakota. None of these was located in such a way as to be dangerous.

Considerable attention has been attracted to the Cronartium on Ribes in Colorado, which so strongly resembles *Cronartium ribicola* as to have been assigned that name. Its Peridermium stage has not been known

[1] Remarks at the close of the conference of the Committee on the Suppression of Pine Blister Disease in North America, held at Pittsburgh, Pa., November 12-13, 1917.

hitherto, but during the past season was found on *Pinus edulis* and *Pinus monophylla*. Although this fungus has had opportunity to pass to planted *Pinus strobus* in Colorado and to native *Pinus flexilis* and *Pinus aristata* it has not done so, although the Cronartium itself is now definitely known to have been on Ribes in Colorado for at least 20 years. It is thus evident that whatever may be the final classification of this fungus with respect to name, it does not need to be considered in relation to the 5-needle pines. It is probably a native fungus which is in no danger of becoming epidemic and which attacks only *Pinus edulis* and related species of nut pines.

On the whole, then, we may say that the situation west of the Mississippi is hopeful. The quarantine now established may be expected to prevent further shipment of 5-needle pines or Ribes into this territory, and so the danger lies entirely in the possibility that the disease may have been introduced into this territory in the past and is not yet found. As has been said repeatedly, if the blister rust should be introduced into this territory and should once become established under western forest conditions, its control even locally would be hopeless. Investigations have shown that there is a continuous distribution of susceptible species of Ribes connecting the ranges of the different species of 5-needle pines and providing natural means for the rapid spread of the disease throughout the West.

In the territory from the Mississippi River to the Hudson River the situation is on the whole hopeful. The disease has not been found in any State south of Ohio. In Minnesota and Wisconsin the eradication areas which were cleaned up last year have remained clean. However, extensive infections have been found outside of those areas in Minnesota and smaller infections in Wisconsin. There is still, however, good reason to suppose that the disease can be eradicated where found, the danger lying in unknown infections which may yet be discovered. Michigan has been thoroughly scouted and, with the exception of one infected nursery, has been found free from the disease. The infected lots of pine in this nursery have been destroyed. The disease has not yet been found in Illinois or Indiana and at but one place in Ohio, and that a nursery. All pine stock in this nursery has been destroyed. In western New York many infections occur on Ribes, some of which have been eradicated and some not. It is interesting to note that the Geneva area, where the disease was first found 12 years ago, is now apparently, after years of effort, free from the disease, at least on Ribes. If the disease does not recur, this place will serve to demonstrate that advance infections, even of considerable age, can be successfully controlled.

The disease has been found at three points in Pennsylvania on pine and eradicated so far as found. It has never been found on Ribes in Pennsylvania. In New Jersey the disease has been found at two points and eradicated. Scouting to the south of Pennsylvania as far as Alabama has revealed no case of the disease.

Perhaps the most dangerous element of the situation in this area is the generally infected condition of Ontario. Not only is the Niagara Peninsula generally infected, but the disease is apparently present on Ribes, at least quite generally throughout Ontario. It is evident that from Ontario the disease can spread naturally into Michigan, and it is possible that it can continue to spread north of the Great Lakes until it infects the white-pine belt of Wisconsin, Minnesota, and Manitoba.

East of the Hudson River the situation could hardly be worse. Infection of Ribes is general, and this, of course, means that infection on pine is also general, although at present apparently only at scattered points. Massachusetts, particularly, is most seriously infected. It is evident that in this territory the only hope for the future growing of white pine lies in local control by the eradication of Ribes. In places where it is financially possible and otherwise practicable to destroy Ribes the white pine can be grown. In other places it may be expected that its culture will have to be given up. The figures presented at this meeting on the cost of Ribes eradication seem to favor the idea that there are many localities where such control will be financially possible, and this view is also favored by the continual increase in the value of white-pine stumpage.

In summing up the situation, we have certain aspects of the case which may be regarded as favorable for the control of the disease. These may be enumerated briefly as follows:

1. The essential freedom of the Western States from the disease.

2. The fact that two large areas in Minnesota, one in Wisconsin, one in New York, and several small areas in Pennsylvania, Ohio, and Indiana have been apparently freed from the disease.

3. The fact that the infections found in the middle territory this season are old and not infections which have gotten loose since control measures were inaugurated.

4. Further research also substantiates the idea that the progress of the disease is slow—that is, slow compared to the progress of a disease which has no alternate host. The much-studied infection at Kittery Point, Maine, is apparently 15 years old, and yet the number of trees infected within the entire eradication of 3 square miles does not at the present time apparently exceed 10 per cent of the whole number,

although infection is complete in the immediate vicinity of oldest infection.

5. Still more hopeful for the continued growing of white pine is the fact that in areas where the disease is generally prevalent local control measures can be inaugurated at any future time by the elimination of Ribes. For example, if in a given area it should not be practicable at the present time to attempt the eradication of Ribes, and the disease should become established there; if at some future time the increasing value of white-pine stumpage or other considerations should make the removal of Ribes practicable, the work could be undertaken and planting and normal reproduction developed, since the disease already present upon white-pine trees would not spread to other white pines in the absence of the intermediary host.

On the other hand, there are certain considerations which are unfavorable for the control of the disease. The first of these is the potential western spread of the disease across New York and westward from Ontario. It does not seem practicable under our political and social system to carry out the immune-zone idea in order to block any large movement of any disease or pest, and, this being the case, it is necessary to calculate the time element in the western spread of the disease in figuring the value of eradication of advance infections. The other considerations opposed to control of the disease are temporary, but none the less serious. Both countries concerned are at war, and in consequence help is scarce, particularly the temporary help for the growing season which is required in this work. During the present season we have experienced the greatest difficulty in securing men at a reasonable price for the work and holding them. We have been compelled in many cases to employ inferior men. Many have enlisted, many have been drafted, and not a few have resigned to accept more lucrative or more permanent employment in industrial lines. We may expect that for the period of the war this condition will grow worse instead of better.

I judge from the discussion which we have had that we are all agreed that our policy for another year must be as follows:

To continue west of the Mississippi River the same program of scouting and tracing suspicious nursery stock that has been carried on during the past year. In the area from the Mississippi River to the Hudson River, to continue the eradication of advance infections and follow up nursery stock in the areas not now known to be infected. East of the Hudson River, however, our policy must be that of purely local control, which must be undertaken in favorable localities of various types on an experimental basis, particularly with a view to determine as soon as possible the financial factors involved in the control work.

In conclusion, we must reflect that the fundamental error was made when European nursery stock of white pine was imported to this country and its extensive importation encouraged. Our problem in this, as in the case of the many other diseases and pests from foreign countries that have been allowed to establish themselves, is to make the best of a very bad situation. The white-pine blister rust has invaded the country and dug itself in. It will never be driven out. Our task is to limit its further spread so far as possible and control it locally in whatever way is most consistent with sound forest economics. In the meantime we should not be unmindful of the fact that ornamental and forest tree nursery stock of other species is still being imported and distributed promiscuously, and the door is wide open for the establishment of other pests and diseases, which may be quite as serious as the chestnut blight or the white-pine blister rust.

FORESTATION PRACTICE IN NORWAY[1]

Sowing or Planting

According to Lindberg, there are several advantages of direct seeding over planting in Norway, namely:

1. No critical period follows the introduction of sown stock in the field, since the plants are accustomed to the local conditions from the start.
2. On sown areas, through natural selection, the best plants survive, which does not take place in plantations, it being impracticable to select the best plants at the age of field planting.
3. As a rule, the loss of a few plants in the sown area does not count, while in plantations fail places must be filled by replanting.
4. Carelessness is apt to be more dangerous in planting than in sowing, the results of the former often being evident only after several years have passed.
5. Seeding is about 40 per cent cheaper than planting, even with seed prices as high as 20 krona per kilogram.

The arguments of the supporters of planting have not always been borne out by experience. However, direct seeding should be avoided on sites and in soils where frost-heaving occurs. The action of frost in lifting out seedlings is described in considerable detail. The danger is shown to be greater on fine-grained soils, while the presence of plant cover and litter reduces the danger. Even planting on such sites should be somewhat deeper than usual to reduce liability of frost-lifting.

Planting is recommended:

1. On sites where frost-heaving is troublesome.
2. On very stony soil.
3. Where plant cover is extremely rank.
4. On very dry, wind-swept and sunny sites.

Sowing is generally advised for all other conditions, and is particularly suited for pine with its rather deep root system, being somewhat less suited for spruce-fir with its more superficial root habit.

Preparation of Clearings for Sowing or Planting

Promising advance growth is usually left, that overtopped by hardwoods being liberated. The larger remaining trunks of deciduous trees

[1] Based on Om Barrträdskulturer i Norrland. By Ferd. Lindberg.

are girdled. On poor soil the presence of a moderate amount of hardwood is beneficial, in that the mouldering leaves add much more fertility to the soil than do coniferous needles. Moreover, better protection is given the stand against snow-pressure, frost, and drouth. If the area is to be planted, brush is usually not burned, but left as a partial protection against grass-growth, animal injury, and drouth. If the area is to be sown, brush may be laid in strips running northwest to southeast on the level, as a protection against the sun, and along the contours on hilly ground, and strips or plots sown between these brush stretches, or the entire area may be burned broadcast before sowing. The writer discusses at considerable length the question of the desirability of burning over areas to be sown.

Broadcast brush-burning is believed advantageous where the soil is not poor. He points out the splendid pine woods now standing on areas which were burned over by forest fires. An early practice of the Finns, which later was adopted by the Swedes themselves, was the burning over of woodland and sowing rye in the ashes. This custom was kept up generally in Norrland until about the middle of the nineteenth century, and the writer enters into the details of the practice very fully. On the areas thus burned, grass and shrubs gradually came back, and about 10 to 15 years after burning, a young pine and spruce-fir stand of high quality invariably occupied the ground. It has also been observed that stands growing on old charcoal burnings are likewise excellent.

Why this advantage in burning? "Ashes contain in soluble form . . . all the mineral constituents which the burned plants had taken from the soil, with the exception of nitrogen, and it is therefore a many-sided fertilizer of as high value as many mixed fertilizers for sale on the markets." It is pointed out that hardwood ashes are richer than coniferous wood ashes, both in potash and in phosphorus.

Burning results in the rapid changing of bulky wood material into plant food without the decade's wait which would be required for its decay. Of course, in the burning, one important food element, nitrogen, is driven off. Opponents of burning argue that it is wasteful in that it destroys the humus layer. However, the writer believes that, excepting with the most sterile soils, the loss of nitrogen through burning of the humus stratum is of subordinate importance, and bases his belief on many areas which he has observed, where plants on burned soil have outstripped in growth neighboring plants on unburned soil. Among others he attributes this in part to the neutralizing of the high acid content of raw humus by the fire, and states that allowing a cut-over area to lie idle for a time will have somewhat the same, although a less decisive result. An area in Indalsliden Parish is cited, where measurements were made in 1914 of plants from seed sown 11 years before on neighboring burned and unburned strips, separated by a 10-meter fire-break. Data follows:

	Average height of plant	Average length of last year's growth
Unburned	2.5 dcm.	6.3 cm.
Burned	8.3 dcm.	17.6 cm.

"That is, the plants on the unburned ground had developed only one-third as fast as the plants on the burned ground." This beneficial effect of burning applies chiefly to pine and less to spruce-fir. With the former it appears to hold good not only in the stand's youth, but throughout the rotation. Any loss of nitrogen near the soil surface would probably not affect the deeper layers, and would speedily be met by increased action of nitrogen-fixing bacteria, by the gradual reforming of a humus layer and through atmospheric electrical discharges.

What Areas to Burn and When and How to Burn

Burning is recommended, but not for spruce-fir, only where pine is to be sown and on soils fairly rich in humus or mineral food elements; also where the sowing is hindered by brush, rich heath vegetation, and decayed material. It is particularly advantageous on clay or marsh soils.

Too small areas cannot be burned economically. Four to five ha. is about right, while tracts larger than 10 ha. permit too much exposure to the influence of drying winds. Where an area is not to be burned, but is to be seeded from the side of the area, it should not exceed 50 to 60 m. in width. Where seed trees on the area are to be depended upon, 50 to 150 pine trees per ha. are sufficient, while because of its greater susceptibility to windthrow spruce-fir requires 250 to 300 trees per ha.

Burning should take place in spring as soon as the ground cover is dry on the cut-over area, but still damp in the near-by woods, while the soil itself in the clearing is yet too cold and damp to permit severe burning. "An old rule is that one should burn while there is one or more snow patches still in the woods." It may also be done in fall, while the soil is damp from rain and yet the ground cover is dry.

Preliminary preparations for burning include the construction of fire-lines around the area to be burned, the felling with tops inward of all standing snags and dead trees near these fire-lines, and the piling of brush away from seed trees. Ant-hills are a menace, since they hold fire for weeks and are liable to set the surrounding country on fire when conditions are favorable, so brush and debris should, if possible, be piled away from them. Large cut-over tracts are first subdivided into blocks by fire-breaks.

The cost of burning is 5 to 10 krona per ha. A crew of 12 to 15 men can, under favorable conditions, burn two clearings of 10 ha. each in 12 hours. Sowing is done in the spring immediately following the burning.

Sowing

Sowing is done in spring; in dry seasons and on dry sites as early as the soil can be worked; in wet springs and frosty sites somewhat later.

Broadcasting.—Broadcasting is done on burned and loosened soil and on ditched marshes. On a given area with living seed trees at the edge broadcasting is confined to the center, and natural regeneration is depended upon to stock up the border. In general, pine is the best species to sow, 0.5 kg. per ha. of 85 per cent seed being used. "Every hectogram of seed is mixed with a liter of dry sand or sawdust, and one liter of this mixture on every one-fifth hectar of marsh, with a hand-sowing apparatus—*i. e.*, a sow-fiddle." The strip sown thus is about 3 to 4 meters broad, and a liter of the mixture should cover a strip 500 to 650 m. long. One man should sow 3 to 4 ha. per day.

Sowing in Stretches.—A "stretch" is ordinarily 5 by 50 cm. in extent, and made with a claw-hoe or mattock, by hoeing up the soil to a depth of 10 to 15 cm. and mixing refined humus or ashes into the mineral soil. On level ground these stretches are laid out in a northwest-southeast direction, as a protection against the afternoon sun. On slopes they are arranged along the contours to prevent the seed being washed away. Narrow strips like this are advised where frost-heaving is feared; also where cattle are apt to trample. The latter are attracted by the soft earth and prefer to walk in the stretches when they are made wide enough. However, a width of 5 cm. is too narrow to permit this. On steep slopes the seeds wash less in narrow stretches. The width may be increased to 10 cm. on level ground where frost-heaving, cattle trampling, and washing are not feared. On sites where frost is especially active, the stretch is made as small as possible, only 20 to 25 cm. long, very little, if any, soil-loosening being done, and it is sown with around 60 to 75 of 85 per cent seeds per stretch, or rather heavily, since the resulting denser root growth helps bind the soil. Under ordinary conditions, where 5 by 50 cm. stretches are used, 25 seeds of 85 per cent grade is a common number to sow per unit. Sowing is done preferably with the Anderson sowing bottle, with an ordinary ale bottle, or by hand, "after which the strip is filled with cover soil and litter."

Plot Sowing.—The size of the plot or seed spot depends upon the size and vigor of the living plant cover and varies from 20 by 20 cm. to 75 by 75 cm. The smaller size is suited for burned areas or where there is little plant cover. Ordinarily 30 by 30 cm. is about right. As the brush and herbaceous growth increases, the size of the plot is also increased, while with particularly dense cover sowing is abandoned in favor of planting.

For preparation of the seed-spot, a Wesslen's sowing hoe is recommended most highly. This tool has two blades—one a hoe, the other bearing three strong claws. The living ground cover is first removed and trampled down on the sunny side of the plot to afford some protection against the sun. The leaf mold, raw humus, or ashes is carefully removed, and after the soil beneath has been loosened to a depth of 20 cm. they are thoroughly incorporated in the upper 10 to 15 cm. of the latter. On very coarse, dry sand soil loosening is avoided as much as possible, because it aids drying out. Elsewhere it is beneficial, because of the better access of the soil to air and warmth, which promotes those changes of the soil elements which make them available for the plant's use. The young tree's roots will go deeper in the loose soil and it will be more resistant to drouth and frost. The adding of humus or swamp-mire to seed-spots in very poor sand soil is recommended.

Before sowing the seed the soil is well tamped. The amount of seed sown depends upon its germinative capacity. Using Haack's figures, the following number of seeds of different germination per cents are proper for a 30 by 30 cm. seed-spot:

Germination per cent..................	60	65	70	75	80	85	90	95
Required number of seed..............	60	50	40	35	30	25	20	15

Not to exceed 0.5 kg. per ha. should ordinarily be necessary, although the amount would be increased in dry, frosty, or very brushy and weedy sites. The writer praises both the Hallstrom sowing can and the Gammelkroppa Nursery sowing apparatus, both of which regulate the amount sown and have seed-spreading devices and rain shields. A sowing flask or ale bottle may be used. The seed should be well shaken before filling the sowing apparatus, otherwise light seed, brought to the top of the bag or canister during transportation, will be unevenly distributed, to the disadvantage of some of the seed-spots.

After sowing, the seed is tamped into the soil of the seed-spot with the foot, unless the soil is so wet that the seeds adhere to the shoes. The cover soil, well crumbled with the hands, is scattered over the seed to a depth of 10 to 15 mm., but *not packed* under any circumstances. While this loose upper soil layer readily dries out, it is a poor conductor of water upward from below and conserves moisture. It permits even a light precipitation to enter the seed-spot and prevents crust formation. Frost action, too, is less marked in loose soil. On top of the cover soil should be scattered litter and leaf debris, which shade the soil and preserve the moisture content beneath without hindering the young plants. A large stone or piece of wood placed on the south side of the seed-spot protects it from the sun and, when the area is not fenced, from cattle also. Laying tree branches over the plots is advised against. It may result in hindered or crippled development of the young trees. The seed-spot is located on the north side of stumps and stones, where the latter are present, so as to permit shading during the hottest period of the day.

A crew of 8 to 10 men, with one sower for every 4 to 5 hoers, is recommended. Such a crew, using a 1.5 m. square spacing, will sow about 1 ha. per day.

Brief mention is made of certain horse-drawn implements for preparing the soil of areas to be sown by the seed-spot method.

Choice of Seed

"Pine seed should always be used from the region itself, or, if this is impossible, from localities with similar climatic conditions. . . If necessary from circumstances to take seed from another source, one should never take pine seed from a more southerly or climatically better region, but rather from a more northerly or climatically worse region." Pine from southerly sources may develop well at first, but later their unsuitability to the climatic conditions is revealed. "With a probability—bordering on certainty—it can be maintained that the lack of success in the greater part of the older sowings in Norrland is due to improper seed source."

Source of seed appears to play a less important part with spruce and fir. While German pine seed is very undesirable, it is permissible, provided no home-grown seed is available, to use German spruce and fir seed from Harz, Thuringia, and the Bohmerwald, in the southern part of Sweden. The importance of collecting seed from healthy stock is emphasized.

Field Planting

Planting should be done as early in spring as the ground permits. New shoots must not be allowed to develop on pine stock to be planted. For late planting it is considered advisable to take up the stock in a dormant state and to place it in cold storage. "Spruce and fir plants may in necessity be planted even after starting to grow."

The planting tool in common use is a sort of long-handled dibble, with a rounded steel or iron-shod point. When forced perpendicularly into the ground it makes a hole 6 to 7 cm. in diameter, which is wide enough to insure getting the roots properly arranged. Previously a smaller, sharper-pointed bar had been used, giving a funnel-shaped hole which had to be widened by working the handle of the bar from side to side. This has resulted in pockets being formed around the roots, which could not be filled properly. Moreover, because of the small hole, "the planter has not been able to see how the roots were accommodated in the hole and has worked blindly, and the very shape of the hole hindering the self-adjustment of the roots, they have often been crooked. Frequently, especially when the roots were long, the root tips have been caught near the ground surface and root placed in the hole doubled up." An unnatural placing of the roots causes very considerable losses of pine stock after field planting.

Besides the planting tool, each planter is provided with a wooden basket-like container for filling-earth, "a gunny sack for covering the plants," and a ball-pointed, wooden tamper for packing the soil around the roots. "Each laborer engaged in digging, preparing, and transporting filling-earth requires a spade, carrying yoke, and two galvanized buckets. The filling-earth used should not frost-heave badly and should contain some woods-mold ashes, or bog mire. If suitable soil is lacking on the area, it can be hauled in and piled at convenient points. From 0.5 to 0.7 liters of earth are needed per plant hole. The foreman of the crew deals out the stock to the planters."

Planting Stock

2–0 pine and 3–0 spruce-fir stock is used. The practice of dipping the roots in a mixture of water, wood mulch, sand, and clay, after taking them from the seed bed, is said to protect them against drying-out and to permit them to be placed more readily in the planting hole. However, on sites where frost-heaving is feared and where the roots should be well spread out "unpuddled plants must be used." When the stock is lifted from the seed bed, the strongest plants of best color and bud development are sorted out and put in bunches of 100 plants each. With spruce-fir it is best to select the light-green plants rather than the dark green for field planting, since the latter, although thriftier in the seed bed, remain stationary when planted on less favorable sites, while the former soon become vigorous and dark colored. Strong transplants 1–1 pine and 1–2 spruce-fir are used where the living plant cover is especially dense.

The Planting

The plants are wrapped with moist moss and carried in a gunny sack or tin receptacle. After the hole is made, a little soil is dropped in it and the plant inserted, with roots spread out, so that it stands lower than it is intended to be left. "It is then drawn up to the proper height for pine, so that the stem's lowest lateral buds, or where these are lacking the lowest whorl of leaves are flush with the ground, and for spruce-fir the same height as in the seed bed, which is easily discernible in the transition from the darker bark to the lighter-colored root bark." Planting of pines deeper than in the nursery is not disadvantageous, since this species naturally develop a deep root-system. Spruce-fir, however, should not be planted deeper than it originally stood.

"The crooks in the roots not righted in the above-mentioned lowering and raising are straightened out with the planting-stick and the roots are given as normal a position as possible. Too long roots are cut off with a knife rather than allowed to remain bent." When there is danger of frost-heaving, the plant is set slightly deeper and against one side of the hole. Filling-earth is given successive *gentle* tampings until the plant seems firm. The upper surface soil is left loose. As in seed-spot sowing, litter is placed around the plant, and a stone is frequently placed on the sunny side to protect from drouth.

A planting crew commonly consists of three diggers, nine planters, and one or two men carrying filling-earth. A careful scheme of lining up the plants in rows is practiced. Planting is omitted where natural reproduction is present.

Site

"Every species should stand on ground suitable for it." Thus in a heavy plant spruce and fir, because of their greater tolerance, will survive where pine cannot.

Soil Preparation

Where the nursery seed beds are to be placed, the soil may be loosened the preceding fall to 20 to 25 cm. in depth, and again in spring to a depth of 15 to 17 cm. Deeper loosening should be avoided to prevent the formation of too long or weak roots.

The advantages of lime as a fertilizer are:

1. Lime favors bacterial life in the soil, thus promoting the change of insoluble combinations into forms which are available to the plants.

2. It encourages root-growth.

3. It improves the physical properties of the soil.

4. It promotes the absorption of free nitrogen from the air.

Lime may be applied in the form of burned lime, slacked lime, and powdered limestone. The first two have a caustic effect and should not be applied in the spring before sowing, but the preceding fall, so that the germinating seed and young plants will not be injured. Powdered limestone, on the other hand, is mild in its effect and can be applied immediately before sowing. "In the liming of woods soil, as in the cultivation of farm land, it should be taken into consideration that as a consequence of liming the soil elements are more readily changed into nutrients or, in other words, used up faster. Therefore, especially poor soils should be manured at the time of liming, the manure being first worked into the soil."

The fertilizing effect of ashes, turf and mire soils, and coal dust, and the ameliorating influence of sand are touched upon.

Spacing in Planting and Direct Seeding

Among the advantages of a closed stand over an open one are:

1. The ground is shaded earlier and protected from drying out and underbrush.

2. The trees develop a better form.

3. The resulting natural selection produces a stand of the strongest individuals.

Since the cost of planting increases as the spacing interval decreases, "in Norrland, with its long distances, shortage of labor, and high day-wage, higher than in the rest of Sweden, it is necessary to use as roomy a spacing as possible, without risking either the ground's or stand's welfare."

Pine, spruce, and fir do not profit by the same spacing. The former early differentiate themselves into crown classes and a culling or thinning may be long postponed, with relatively little risk. Spruce and fir develop very uniformly, and unless thinned the individuals soon hold each other back in growth to the detriment of all. Open-spaced pine does not protect the soil as well as similarly spaced spruce-fir. The latter need a more open spacing to make it windfirm. The investigations of Professor Kuntze, of Theraudt, in 50-year-old pine and 45-year-old spruce stands show that close spacing of pine results in greater timber production, while a more open spacing of spruce and fir gave larger diameter and height growth of this species. For Norrland a square spacing for pine of 1.5 to 1.7 m. and for spruce and fir of 1.7 to 2.0 m. is recommended. A square spacing of 2.0 m. is thought best for "Northern pine (*P. lapponica*)." Of course, it should be considered that the closer spacing may be the cheaper in the end, since less replanting will be needed.

In general, closer spacings are selected for:

1. "Poor soil, in order to hasten the humus building through a heavy leaf-fall."
2. "Ground, where quick shade is necessary to kill off and hinder the growth of luxuriant ground vegetation."
3. Where one wishes to produce well-developed material clear of branches.

More open spacings are selected for:

1. "More fertile ground."
2. Ground where ground vegetation is not heavy.
3. When well-developed, branch-free material is not necessary.
4. Where one cannot afford the higher planting cost.

Replanting

Among the principal causes of loss of both planted and sown stock in the field are trampling by cattle, drying out, frost action, insects (*e. g., Agrostis segetum, Lyda erythrocephala, Hylobius abietis,* in southern Norrland), and the snow fungus *Phacidium infestans.* In a stand from direct seeding there is ordinarily little need of replacement, since the stand has purposely been sown rather dense. In plantations, however, particularly in the more open spacings, careful attention must be paid to the filling of blanks.

The result of a direct sowing cannot be judged until the plants begin their third year's growth, while the result of planting can be determined during the second summer after the work. The best time to fill fail places, as well as the proper interval between examinations, are both touched upon, and the writer closes with this statement:

"It should always be remembered that a plantation which is denser from the beginning, though a plant dies here and there, closes, as a rule, to a splendid stand, without improvement, while spacings open to start with require replacement, even with relatively few accidents."

TREE GROWTH IN THE VICINITY OF GRINNELL, IOWA

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We are filled with wonder when we stand today on what was once the endless grassy prairie and find our view shut off on every side by trees. Towns of thousands of inhabitants are almost hidden by foliage, and of the school-houses that stand but two miles apart in each direction scarcely one-third would be detected in a bird's-eye view. Every farm-house is sheltered, if not hidden, by trees, and there are groves and orchards beside. Such, at least, is the landscape round about Grinnell. We know not whether to wonder more at the evidence of human industry or at the bountiful response of nature. Professor Shimek[1] has recently discussed in a masterly monograph the problem of the prairie. Upon this ground, therefore, we now fear to tread. The present paper presents some accurate data on tree growth in Poweshiek, Jasper, and Mahaska counties, Iowa. These notes have been collected by various observers during the past ten years; but the fullest records are of certain tracts in Jasper County, collected by Horace J. Adkins in the spring of 1912.

Two types of soil cover probably 90 per cent of the region under discussion—the Marshall and the Miami silt loams. Both are composed primarily of the same fine-grained loess. The Marshall silt loam is most typical on broad, level highlands, where the run-off of rainfall is small. Soil moisture has favored the retention of humus from the remains of countless generations of grasses; hence the dark color of the soil. A large amount of calcium carbonate—triturated limestone from the Iowan glacial drift—keeps the soil sweet and friable. The Miami silt loam is found on hilly ground, where better drainage favors eremacausis. It is of a paler color and clayey texture, like the subsoil of Marshall. In very small areas on hilly ground, where loess has either failed to accumulate or has been washed away, appears the Marshall loam. It is a pure, gravelly glacial drift, worked over by vegetation. Along the streams is the black Kaskaskia loam. This forms a strip proportional in width to the drainage basin in which it lies. On Skunk

[1] Shimek, B.: The Prairies. Bulletin Lab. Nat. History, State Univ. Iowa, Vol. 6, No. 2, pp. 171-240, 1911.

River it may be a mile wide; and it disappears on the smaller streams only where they become intermittent bearers of surface drainage. It consists of miscellaneous washings from higher ground, enriched by humus and humic substances.

Only the Miami and Kaskaskia soils were originally timbered. The Kaskaskia loam was often heavily timbered in the more protected river bottoms. These differences in soil are both cause and effect of the characteristic vegetation of the soil areas.

The following descriptions of these soils as they occur in Tama County, next north of Poweshiek, apply precisely to the region under discussion. The Marshall silt loam "was originally covered with prairie grass, and its present dark color is due to the organic matter which has been incorporated in the soil. . . . The difference between this type of soil and the Miami silt loam is largely one of organic matter, and this has been brought about by the difference in topography and in native vegetation" (p. 12).[2]

The Miami silt loam "was originally timbered with oak, hickory, elm, maple, and hazel brush. . . . The Miami silt loam occupies the most hilly land in the county" (p. 14).

"The Kaskaskia loam is an alluvial deposit left on the bottoms when the streams overflowed, added to, to some extent, near the hills and on the smaller streams, by wash from the surrounding types. As these bottoms were once timbered and were more or less damp, the organic matter was not completely removed by decomposition processes, but accumulated from year to year, which accounts for their present dark color" (p. 17).

"The Marshall loam, to a depth of 10 to 14 inches, is a rather heavy brown loam, similar in color to the Marshall silt loam, but differing from it in containing considerably more fine sand. . . . The type is always found in small, scattered areas, ranging from 5 acres up to half a square mile in extent, and naturally well drained. It is the only soil in Tama County formed directly from the glacial drift, and is developed in places where the loess was deposited as a very thin layer, or where it has been washed away" (pp. 19-20).

TIMBER ON THE MIAMI SILT LOAM

The natural timber may be discussed, therefore, as it occurs on the Miami silt loam and on the Kaskaskia loam. The dominant tree on the

[2] Soil Survey of Tama County, Iowa. U. S. Dept. of Agri., Bureau of Soils, Washington, 1905.

Miami soil is *Quercus macrocarpa*. It attains a diameter of 3 to 5 feet and a height estimated at 50 to 60 feet. One bur oak in our Jasper County area yielded 137 fence posts. With it occur *Quercus alba, Quercus velutina, Quercus rubra, Carya ovata, Prunus serotina, Populus tremuloides,* and *Ulmus americana*. *Tilia americana* and *Celtis occidentalis* are found at lower levels. *Acer saccharinum* is local.

The foliage of these trees never attains great density. Thick undergrowth of hazel and other shrubs is common, and in many places at present good pasturage of blue-grass (*Poa pratensis*) is found throughout the groves. The trees also stand sparsely on the ground. On one area near Searsboro (Mahaska County) 62 trees were found on an area 50 by 100 feet, making about 496 trees per acre. Of these 62 trees, only 29 were of a diameter of 6 inches or above. This was an especially dense patch of fenced timber, untrodden by stock. The ground was covered with leaves and leaf mold; there was no grass and comparatively little underbrush (see Table 1). A plot in Poweshiek County showed 211 trees per acre (see Table 2), of which 156 were 6 inches or more in diameter.

The outstanding characters of all the timber in this vicinity are the low stature of the trees, the rather thin covering of foliage, admitting much light, and the thinness or absence of leaf mold on the ground. It is further noticeable that the timber is much more plentiful on the slopes which face north or northeast than on any other slope. These slopes are usually steeper than those on the opposite sides of the valley and therefore less clearing has been done upon them. The timber may also have prevented general erosion and tended to produce this peculiar topography.

Several observers agree that since this region was settled the oak and hickory timber has spread up and out upon the prairie. Looking across the hills southwest of Searsboro, we are told that 50 years ago one could see over the hilltops for miles, where now the view is entirely shut in by natural timber. Marked encroachment has occurred also southwest of Grinnell. This advance cannot be accounted for by a change of climate. It must be due either to the weakening of the prairie grass due to tillage and pasturage or to the elimination of the prairie fires. Under the circumstances, the latter theory seems decidedly preferable.

The rate of growth of timber on the Miami silt loam is good, but very few of the trees attain to any great age. Three or four foot oaks must have been some hundreds of years in growing; but we rarely find such. Few counts run over 100 years, and this of course dates far back of the settlement of the region by white men. The average annual growth in diameter is found to be—

0.22 inch for *Carya ovata*.
.29 inch for *Quercus velutina* at its maximum period.
.16 inch for *Quercus velutina* after 30 years of age.
.30 inch for *Quercus macrocarpa*.
.49 inch for *Ulmus fulva*.
.63 inch for *Acer saccharinum*.
.27 inch for *Prunus serotina*.
.34 inch for *Juglans nigra*.

By Pressler's table, *Q. macrocarpa* would thus yield 5.4 per cent interest.

The age at which the maximum growth occurs depends upon a number of circumstances. An elm at 22 years showed an annual increment of 13 per cent; a hickory at 25 years, 8 per cent; bur oak at 40 years, 6 per cent. Three black oaks showed their periods of maximum growth at 10 to 20 years, 18 to 28 years, and 90 to 100 years, respectively; the ages of the trees were 30, 50, and 120 years when cut. Our best figures indicate that *Q. macrocarpa* makes its most rapid growth from 11 to 30 years; *Q. velutina*, 9 to 30; *Prunus serotina*, 17 to 36. A single large bur oak 144 years old made its maximum growth between 124 and 132 years. This was because it was at the beginning of that time freed from competition by the cutting out of the surrounding timber. Thus a vigorous rejuvenation is possible, even at an advanced age. Attempts to find a relation of rate of growth to wet and dry seasons proved futile. Different trees in a single grove showed maximum growth in all of the years from 1874 to 1911. Evidently the seasonal variation in conditions of growth had less influence than other factors upon the rate of growth.

In river bottoms on the Kaskaskia loam the principal tree is *Ulmus fulva*. It grows to large diameter and height. With it occur *Populus deltoides*, the tallest and straightest tree of the region; *Acer saccharinum* and *Acer negundo; Juglans nigra* and *Juglans cinerea; Ulmus americana; Tilia americana; Salix longifolia; Betula nigra*. When these form dense stands, there is no grass on the ground, a thin cover of leaf mold, and more or less underbrush. Often, however, they occur in open parklike formation, with dense grass between. They never make pure stands. *Juglans nigra* sometimes attains a diameter of 4 feet and *Betula nigra* 2½ to 3 feet. *Populus deltoides* is often 4 feet through.

TABLE 1.—*Stand of Timber in a Fenced, Untramped Woodlot, Southwest of Searsboro. The Number of Each **Kind** of Tree of Each Size is Given.*

Name of species	Circumference of trunk in inches													Total
	1–3	3–6	6–9	9–12	12–15	15–18	18–21	21–24	24–30	30–36	55	58	144	
Quercus macrocarpa	..	2	2	6	2	3	3	3	4	1	..	..	1	27
Ulmus americana	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Ulmus fulva	3	4	3	..	..	..	1	..	..	..	..	..	..	11
Carya ovata	..	1	..	2	2	2	2	2	..	..	..	..	..	11
Prunus serotina	..	3	3	..	..	..	..	..	..	..	..	..	..	6
Juglans nigra	..	..	..	..	..	1	..	..	..	..	..	..	..	1
Quercus velutina	..	..	..	..	..	..	..	..	..	..	1	1	..	2
Pyrus ioensis	..	..	3	..	..	..	..	..	..	..	..	..	..	3
Grand total														62

Average: 496 per acre.

TABLE 2.—*Stand of Timber near Grinnell. One Acre.*

Name of species	Circumference of trunk in inches																			Total
	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	
Quercus macrocarpa	..	5	2	9	11	17	20	16	14	5	3	1	1	..	..	1	..	..	1	106
Tilia americana	..	..	1	..	1	..	..	..	2	..	1	3	..	..	1	..	..	..	..	9
Carya ovata	..	1	1	4	5	7	8	2	1	6	4	..	..	..	..	..	..	..	..	39
Ulmus sp.	2	..	1	2	..	2	3	..	4	1	2	4	4	..	1	1	..	..	..	27
Acer negundo	..	..	..	..	..	1	1	..	..	..	1	4	1	1	..	..	..	..	..	9
Prunus serotina	..	..	1	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	3
Pyrus ioensis	..	3	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5
Cratægus sp.	6	3	3	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	13
Grand total																				211

Estimated to Contain as Marketable Firewood

10 cords of oak @ $5	$50.00
4 cords of hickory @ $6	24.00
5 cords of elm @ $5	25.00
	$99.00 per acre

On the originally treeless high prairie of this region, on the Marshall silt loam, about 100 species of trees are now flourishing. With some the rate of growth is prodigious. At first cottonwood, box elder, willow, Lombardy poplar, and soft maple were planted. Elm soon came into prominence and hackberry and ash followed. Orchard trees were early introduced. Our data on these are not so precise as could be desired, but they admit of some very striking conclusions.

Grinnell was settled about 1855. Since that time on a part of the college grounds (Chamberlain Park) a generation of Lombardy poplars has matured and gone; a generation of soft maples, following the poplars, is represented by one large tree 4 feet in diameter, with trunk twisted by the cyclone of 1882. The maples were succeeded at maturity by American elms, which are now 1 to 2 feet in diameter. An elm growing beside an unpaved street and felled in January, 1907, was 27½ inches in diameter and 40 years of age. In the last 23 years the tree made a radial growth of 10 inches, or 20 inches increase in diameter, nearly an inch per year. The growth from 1875 to 1882 was almost as rapid. A row of ash trees (*Fraxinus pennsylvanica*) along a country road averaged about 18 inches in diameter, when cut recently, at the age of 40 years. Cottonwoods are frequently as large as 3 or 4 feet in diameter and not more than 60 years old. The old maple tree in Chamberlain Park is not over 60 years old at the outside. Fruit trees are short lived. The first apple tree of Grinnell is still standing. Most fruit trees become broken and decadent in 25 to 30 years. Apples, pears, and cherries (*Prunus cerasus*) make extremely rapid growth, with densely bushy tops. They require much pruning and thinning and seem to vegetate so luxuriantly as to have little stimulus to fruiting.

All these facts show that the trees of the natural timber and many others find the upland prairie soil and climate most congenial; if anything, too stimulating. The conditions are no less favorable for seedlings. I have counted 27 soft-maple seedlings of second year's growth in a square yard of close blue-grass sod. In hedges and fence rows young box elders, elms, and maples are among our most common weeds. On bare ground elms annually spring up near parent trees so thickly as to obscure the soil when they are only 2 inches tall. We have counted 268 per square foot in the edge of a grove. Maples, box elders, cottonwood, and ash seedlings often appear in great numbers and hackberries and lindens spring up freely under the street trees. In pastures wild crab-apples and Cratægus spp. spring up wherever the seeds are dropped undigested by cattle. I have counted 13 seedlings of Cratægus in one pad of cow manure. When artificially planted, both species of catalpa grow from seed with great rapidity. Thus throughout their whole life trees vegetate here most prosperously. Probably that is one reason why they reach an early maturity and then decay.

CONCLUSIONS

Farmers have long recognized that timber originally was found in central Iowa only on the poorer soils, or on those less suited to agriculture. Their work in planting groves, windbreaks, and orchards shows, however, that the richer upland soils are very favorable for tree growth. The time may come when it will pay to grow timber as a crop on these soils. The increment is great enough; the capital value has, however, not yet made the timber crop the equal of corn.

Just why the high prairie was originally free from trees does not seem to the writer to be fully solved. From the climatic standpoint, we are certainly near the western limit of forest conditions. The low rainfall, the high altitude (about 1,000 feet above tide), and the parching southwest winds of summer are three prime factors in this general limitation of forest. The dense prairie sod was undoubtedly hard to make headway against. Early autumn frosts and late spring frosts must have played a part in hampering the trees. Drought in winter is another factor. At temperatures from zero to 20° Fahrenheit below I have seen the dry, naked ground cracked to a depth of a foot or more, with fissures wide enough to put one's finger in. But the exact boundaries of timber must have been largely determined by the regularly recurring prairie fires, which licked up all surface vegetation, until checked by moist foliage, wet litter, or lingering, protected snow. The elimination of prairie fires is the one environmental change which has been effected by civilization. And where fires still occur, as along railways, trees do not come in.

REVIEWS

The Indicator Significance of Native Vegetation in the Determination of Forest Sites. By C. F. Korstian. Reprint from the *Plant World,* Vol. XX, No. 9, 1917.

A century ago when people from New England went West to settle the Ohio Valley and the Southern Lake States they searched for land covered with beech and hard maple. To them these trees were "indicators" of site quality for the production of corn and wheat. Those who settled on land covered with beech and hard maple fared much better than those who settled on land where oak and pine were dominant. The farmer has from earliest times looked upon trees and lesser plants as indicators of the quality of the soil for the production of agricultural crops.

European foresters have for at least a century gauged the quality of the soil for the production of forest crops from the characteristic forms of lesser vegetation. Thus *Oxalis* in Prussia has been looked upon for generations as an indicator of site quality. Heyer in his "Bodenkunde," published in 1856, emphasizes the significance of indigenous plants as indicators of site quality. Ratzeburg, in 1859, published a good-sized volume under the title "Standortsgewächse," treating the subject *in extenso.* Ramann, in 1893, in his "Bodenkunde" devotes a number of pages to "Bodenbestimmende Pflanzen," which may be liberally translated as "soil-determining plants or indicators."

In reading Korstian's article the reviewer is left with the impression that the use of plants as indicators of soil quality is new to forestry. He says: "In the perusal of forestry literature one is impressed with the apparent fact that until only recently has much attention been given to the native vegetation, aside from forest trees themselves, in the classification and segregation of forest sites."

Although the plant ecologist has only recently made use of indigenous plants as indicators of soil quality favorable or unfavorable for particular crops, the forester has long made use of native plants, both herbaceous and perennial, as indicators of soil quality, favorable or unfavorable for particular forest crops, as indicated by the writings cited above.

Although Shantz, in 1911, in a bulletin published by the U. S. Department of Agriculture, showed the value of native vegetation as an indicator of the capacity of land for crop production in the Great Plains area, no equally comprehensive treatise has as yet appeared in this country showing the use of native plants as indicators of the capability of land for forest crop production. Cajander, however, has recently treated the native vegetation of central and eastern Europe in a comprehensive manner as indicators of site quality in the demarkation of forest types.

Korstian's article serves a very useful purpose, however, in calling the attention of American foresters to the indicator significance of the lesser forest vegetation in determining site quality. It briefly cites the more important American literature, correlating the distribution of native vegetation with site and the utilization of such a correlation in the classification of the agricultural potentialities of the land and also the recent literature on the use of native vegetation as indicators of forest sites. These studies were made in connection with the measurement of permanent sample plots on the Datil National Forest in New Mexico. Summaries were made of the vegetation on 53 list quadrats, and tabulations were made of the per cent of quadrats on which the different species occurred. The results so far secured have led the author to initiate studies, which are now under way, to determine the feasibility of using native plants as indicators of suitable forest-planting sites. He believes that careful studies on the indicator significance of native vegetation will be of great value in explaining the presence or absence of tree growth on certain areas, in the selecting of species and sites in reforestation, and in establishing a working basis for the classification of the potential productivity of forest lands.

J. W. T.

Forests of Porto Rico—Past, Present, and Future—and their Physical and Economic Environments. By Louis S. Murphy. Department of Agriculture, Bulletin No. 354; contribution from the Forest Service. Pp. 98. Figs. 7. Plates XII. Washington, D. C., 1916.

In co-operation with the Government of Porto Rico Board of Commissioners of Agriculture, Louis S. Murphy, of the United States Forest Service, publishes a comprehensive bulletin on the forests of Porto Rico. This bulletin is unique in that it discusses the past, present, and future conditions of the forests. From it we learn that Porto Rico is about four times as large as Long Island; that in density of population it ranks fourth among the political subdivisions of American territory, and only Rhode Island, Massachusetts, and New Jersey exceed it in this respect. In the central mountainous region is found the heaviest rainfall, amounting to a maximum of 169 inches. Abundant rain and the absence of protracted droughts characterize the north side of the island; the reverse is true on the south side, where several months will elapse with little or no rain.

While the island was originally covered with virgin forests, but 2 per cent of the total land area now contains virgin forests; but the total wood area, including virgin and second growth forests, is estimated to be 20 per cent of the total land area. A small map is published showing the original distribution of the forest formations, as follows: First, littoral wood lands, 8 per cent; moist deciduous forests, 7 per cent; tropical rain forests, 62 per cent; dry deciduous forests, 23 per cent.

The cause of the destruction of the forests is due to clearings made for permanent agriculture, to the heavy demands for wood of all kinds by the large population, and by the so-called "conuco" cultivation. This "conuco" form of cultivation is prevalent in all tropical regions and is the main cause for the scarcity of timber in many of them. It is a primitive method of agriculture in which a small area is selected in either the virgin or second-growth forests, the timber is felled and burned, and the land crudely farmed for a few years and then abandoned by the cultivator.

The author states that the planting of new forests is by far the most important forestry work to be done in Porto Rico. He thinks that this work can be done most effectively by the insular government itself. In addition, of course, it should undertake a campaign of education, investigative work in forestry, the care and management of the most suitable parts of the insular domain for insular forests, and a co-operation with private individuals, municipalities, and others interested in the practice of forestry. While some forest legislation has been enacted, there is need for further legislation that will protect the present forested area and control the waste in the forests so far as possible.

Appendix I, entitled "Trees of Porto Rico," contains a brief description of some 172 woody species, and Appendix II contains a list of the books consulted in the preparation of the bulletin. This bulletin is a timely one and should be carefully read by all who have interest in our newest territory. It is the presentation of the forest conditions on an island that is practically destitute of commercial timber. There is an excellent chance for the Porto Rican Government, as a part of the United States, not only to materially increase the quantity and quality of its local fuel supply, which is urgent, but to demonstrate the raising of certain tropical timber trees, such as Spanish cedar and mahogany and other tropical woods, that will go far toward insuring a steady supply of these timbers for future generations.

One criticism that the reviewer has of this bulletin is the attempt that has been made to compare the forest formations with those of similar formations in other parts of the world. Such an attempt is more than likely to fall short of the truth, especially when the author has not had an opportunity to study those of other tropical countries.

H. N. W.

Statistics Compiled in the Office of the Silviculturalist, Forest Research Institute, Dehra Dun, During 1915-16. The Indian Forest Records, Vol. VI, Part II, 1917.

The compilation of statistics relating to the growth and yield of Indian trees, although begun in India a number of years ago, lacked continuity and uniformity in the methods of measurement. In 1913 the board of forestry considered methods and forms, and since then the methods of measurement have been more uniform. There have also been more uniform methods in the tabulated data. Even yet, however, lack of continuity and uniformity exists, making it impossible to utilize much good work.

Experience in India indicates that growth and yield studies require the appointment of special offices to establish, supervise, and maintain sample plots and experimental areas. This work has been the function of the silviculturist, but it is impossible for one officer to supervise and control sample plots throughout India, and the appointment of a special officer in each province is highly desirable, owing to the urgent need of extending silvicultural research.

In the publication under review the statistics on growth and yield have been computed from the following sources:

(*a*) Periodical girth measurements of selected trees, recorded in registers by divisional forest officers; the registers have been sent to the silviculturist, the trees have been classified into girth classes, the average increment for each girth class calculated, and curves prepared for each sample area; from the curves the girth for each 10-year period has been read off.

(*b*) Outturn registers of individual trees maintained by divisional officers. After classification into girth classes, averages have been calculated for each coupe. The yield of each tree is entered in the register by a clerk on the spot as conversion is effected. Little supervision is possible, and the accuracy of the entries for any single tree or even for a whole coupe is open to question. But the averages for the different coupes check each other, and on the whole they yield an approximate estimate of the outturn under present conditions.

(*c*) Sample plots established and maintained by the silviculturist. The first plots were laid out in 1910-11 and their remeasurement was carried out in 1915-16. Fresh plots have been formed annually since 1910-11 and remeasurements are to be made at intervals of five years, so that every year certain plots will fall due.

(*d*) Miscellaneous investigations by officers acting independently.

The publication of the statistics is to show the rate of growth and yield under present conditions. They should be useful in showing the need of change of species and change of treatment. They should also be useful to working-plans officers in framing estimates. As the figures are in most cases very incomplete and apply only to definite localities, the direct application of the statistics is, however, out of the question. As yet they are little more than suggestive. A series of graphs showing the growth of teak in three different types of forest are of particular interest. From these graphs it is possible to determine at a glance the time required for the yield of timber of various forms and sizes. These statistics should be of special interest to silviculturists in the United States who are now studying growth and yield by means of permanent sample plots. They should emphasize in this country the need of uniformity. It is hoped that through the Committee on Forestry of the National Research Council we will be able to secure greater uniformity in the studies on growth and yield in this country, thus making it possible to compare results derived from the work of different investigators.

H. N. W.

Commercial Woods of the Philippines: Their Preparation and Uses. By E. E. Schneider. Bulletin No. 14, Bureau of Forestry, Philippine Islands. Pp. 274. Figs. 12. Plates X. Manila, 1916.

Not since the publication of Gamble's Manual of Indian Timbers has there appeared so complete a treatment of the woods of a tropical region as Schneider's Commercial Woods of the Philippines. Two things are combined to make this a successful piece of work. The first is that for fifteen years the officials of the Bureau of Forestry of the Philippines have co-operated with the botanist of the Bureau of Science in the collection of wood specimens combined with botanical material. This insures the proper determination of the woods. The second is that the author, who has the title of wood expert in the Bureau of Forestry, has knowledge gained from experience by having worked with the woods himself. He is acquainted with them as a man who uses them is and is in a position to speak whereof he knows. In his treatment, under the heading of "Working and finishing," he makes the following statements as regards the "hard tropical" woods:

1. The softer commercial woods of the Philippines are much easier to work than the oaks or hickories.

2. They are more abundant, not in the number of species, but in total bulk, than the hard and heavy woods.

3. They are being exported in greater quantities than the very hard woods.

4. The heavier woods are, as a rule, difficult to work only on account of their hardness and not especially on account of other qualities, such as toughness or crossed or curly grain.

The bulletin is divided into five parts. In Part I the forests, the timber supply, and the markets are discussed. Part II treats of the properties of the woods, the methods of conversion, working and finishing, and the preservation treatment. Part III is a comprehensive treatment of the uses of the woods. This differs from the usual treatment of the subject in that the author does not confine himself to a mere list of the woods that are used for certain purposes, but discusses in some detail the choice that is open to the user, taking into consideration the abundance and the cost of the wood itself. Part IV is a discussion of the methods of identification that is practical to any one who knows how to use a jackknife, a fine white stone, and a lens magnifying four or five diameters. In Part V, the species descriptions, there is a very comprehensive treatment of some 468 woods, arranged according to families, genera, and species. These descriptions include a general consideration of the family and something of its commercial importance. Then follows a description of each wood, under the following headings: Local names, gross structure (including workability and durability), uses, supply, and prices. Species that are important are given more space than those that are not so.

Appendices II to IV treat of the economical properties of thirty-four Philippine woods, the shipping weights, grading rules, and durability of sapwood. There is also a general index, an index of the common names, and one of the scientific names.

H. N. W.

Report of the Forester for 1916 (being the Ninth Report of the State Forester). Part VI of the Annual Report of the Connecticut Agricultural Experiment Station. Pp. 379-427.

It is not quite clear in what capacity this report is made by W. O. Filley, who holds three titles, namely, Forester (of the station), State Forester, and State Forest Fire Warden. Outside of a short reference to the attempts at control of the white-pine blister rust, the three pages he contributes refer to the forest-fire situation in his State.

Due to favorable weather conditions, fires were relatively few and small, and while in the preceding two years the losses were valued at around $20,000, in 1916 they were reduced to $4,500. This is not to the credit of any efficient protective arrangements, for evidently such do not exist. A radical change in the existing fire-warden system would be necessary to accomplish results. We note particularly that 45 per cent of the fires are charged to railroads—a cause which can be almost absolutely removed, as the experience in Canada has proved.

The bulk of the report is contributed by the Assistant Forester, A. E. Moss, and consists of an account of a descriptive forest survey of one town, that of Redding, located in the hill country of the southwest portion of the State, as a sample of similar conditions in the more heavily wooded counties of the State.

With 8,880 acres or 43 per cent of the town forest-covered (64 per cent) or waste land only fit for wood crops (36 per cent), the town should be interested, from the tax point of view, in a better utilization of the soil. The present condition of the area, mostly in farmers' woodlots and mostly coppice, is quite hopeless and planting alone promises satisfaction. The existing forest, more than half the composition being of weed trees, does not seem to be much more than paying taxes at present. A somewhat unclear and, we are afraid, unsafe calculation under various assumptions, among them a rotation of 50 years, brings the possible annual cut from the possible acreage of 6,900 acres changed to pine to 4,800,000 feet b. m. The absence of a market for cordwood would make this change to pine (without considering blister rust) rather a doubtful procedure.

B. E. F.

The Forests of Maryland. By F. W. Besley. Maryland State Board of Forestry. Baltimore, Md. 1916. Pp. 152.

In a magnificent, well illustrated, quarto volume, worthy of the State, here are presented the final results of a forest survey of the State, which has been going on for seven years. As far as we know, Maryland is the first State to have such a comprehensive and detailed survey made, unless the forest survey of the Province of Nova Scotia is admitted to be of the same class.

The general discussion occupies only 30 pages, followed by detail descriptions, county by county, each county accompanied by a map on a scale of 3 miles to the inch, showing the distribution of types of forest and conditions by colors and signs, including stand of saw timber. The whole information for each county, character distribution and uses of forests, with tables of lumber and lumber cut, is condensed in 4 pages. Summaries and an account of the forest laws of Maryland occupy 12 pages at the end of the volume.

Briefing the generally interesting facts, we may state the following: While 51 per cent of the 9,891 square miles of land area are improved farm land, 14 per cent are waste and marshy, the balance of 35 per cent, equal to 2.228 million acres, are woodland. Three broad composition types are recognized, namely, mixed hardwoods, which occupy 65 per cent; pine, which occupies 15 per cent, and mixed pine and hardwood, 20 per cent. Less than 1 per cent of virgin forest remains. While in some sections clearing is going on rapidly, in other parts abandoned fields grow up to forest, so that the total remains about the same. There are 70 species enumerated, of which, however, a number is without economic value.

One chapter is devoted to a discussion of the uses of the forest; lumber production in 1914, amounting to around 230 million feet b. m., representing a value of $3,800,000, now largely distributed over the whole State and promising to continue at this reduced rate for many years. A guess is made that the per acre increment over the whole State may not exceed 15 cubic feet, making the total growth around 33 million feet as against a consumption of 47 million feet and the stand of timber 318 million cubic feet.

Pulpwood, piling, mine props, cordwood, cooperage stock, poles, railroad ties, and tanbark are referred to as contributing to forest revenue, which may be altogether placed at 5 to 6 million dollars.

The State has so far only four small forest reserves, not quite 2,800 acres in all, partly donated, partly purchased. Park purposes and perhaps small demonstrations of silvicultural management may be served by these areas.

Two notable examples of municipal forest ownership are cited, namely, Baltimore owning a water reservoir tract, of which 2,000 acres are wooded, and Frederick owning 1,200 acres of wooded watershed.

In co-operation with this latter city, the State forester hopes to make revenue from the management of these reserves.

Planting will be necessary on these watersheds, in which the State nursery, established in 1914, may serve, from which applicants can secure material at cost. As the charge made for this stock is in the neighborhood of $7 per thousand—the list for various stocks varying from $4 to $18—it seems a questionable advantage. We see that black locust and catalpa have played an undeserved rôle in previous distributions. The State itself has planted 475 acres. Although there is a State protective organization of 148 forest wardens (without salary), the damage from fire during the last five years averaged over $100,000. "The system of fire protection in operation is as effective as it is possible to make it without increased appropriation."

Attention is given to insect and fungous diseases; among the latter the chestnut blight has been in the State since 1910 and has caused considerable damage.

B. E. F.

Studier över salpeterbildningen i naturliga jordmåner och dess betydelse i växtekologiskt avseende. Skogsvårdsföreningens Tidskrift, April-June, 1917. Pp. 321-446.

Notable advances have been made in recent years in the investigation of the composition of soils and the formation of humus. Among these researches may be mentioned the work of Suzuki (1906-08), who by means of the ester method devised by Emil Fischer has succeeded in isolating from natural humus a number of monoamino and diamino acids, presumably decomposition products of albuminous substances found in the soil. Robinson (1911) has succeeded in isolating from peat such compounds as leucine and iso-leucine. Much has been accomplished by Schreiner and his associates in the United States Bureau of Soils, who have isolated the following compounds from soils containing small amounts of humus: Xanthine, hypoxanthine, adenine, arginine, lysine, histidine, koline, trimethylamine, and also non-nitrogenous compounds, among which are phytosterine, agrosterine, oxalic acid, mannitol, and rhamnose. Schreiner has even found it possible to isolate from such soils certain organic compounds that are toxic to higher plants, as, for instance, dihydrooxy-stearic acid.

Important as these American researches are, Hesselman cautions his readers that their value must not be overestimated. With the exception of Robinson's studies on peat, they deal only with light-colored earths containing but little humus, and there is no evidence to show that the dark-colored, sour humus of coniferous forests contains the same compounds. The reason for the acid reaction of such soil is a matter that has provoked much discussion. Baumann (1909-13) and Gully (1915) at München have sought to establish that humus is composed of substances that are neutral and of colloid nature, and that the acid reaction is caused by the absorption of the positive ion from mineral salt solutions found in the ground water. This theory has, however, been very strongly contested by Rindell (1911) and Odén (1916), the latter (1912-16) having isolated from peat and other acid soils a tribasic organic acid of high molecular weight. Hesselman observes that as colloids flocculate when a mineral salt is added to the solution, humus lying on soils containing a plentiful supply of water-soluble mineral salts is less apt to give an acid reaction, for the humus particles become aggregated and granular, permitting the penetration of roots, insects, and earthworms with the consequent aëration of the humus. To illustrate this point, he cites that the water found in the bogs and sump land in the forests of Norrland, where the soil is of basaltic origin, is brown and discolored, while similar water in the limy forest soils of Jämtland is fresh and clear.

In reviewing former researches on the composition of forest soils, Hesselman reaches the following conclusions:

1. From earth containing relatively little humus, and to a lesser extent from peat, it has been possible to isolate organic compounds of known composition. In certain cases the isolated and identified compounds constitute a considerable proportion of the humus found in the soil.

2. Many forms of humus, especially those of dark color, are composed to a considerable degree of chemical compounds of undetermined characteristics.

3. The acid reaction of certain humus soils is due to the presence of free organic acids.

4. In the main, the constituents of humus are colloidal in nature, and the physical structure of the humus soil is therefore greatly influenced by the amount of mineral salts or electrolytes in the soil and ground water.

Hasselman distinguishes between two types of humus soils—"mild humus" soil, which has been well aërated through the action of worms and insects, and "raw humus," a mixture of decomposed and decomposing leaves and litter. Mild humus is characteristically found in hardwood forests, and less commonly in coniferous forests on earths containing a high percentage of mineral salts. Raw humus is found in coniferous forests of the more usual type, and such humus can often be stripped from the bare mineral soil in a series of layers in various stages of decomposition.

The combinations of nitrates in the soil and their distribution has a direct influence upon the productive capacity of the soil. Litter always contains a certain amount of nitrogen, and a knowledge of the soil processes through which the nitrogen is converted into an assimilable form should be of great importance. This is now occupying the attention of a number of prominent investigators and much has already been accomplished. It is known that the decomposition of humus is attended by the liberation of ammonia, which can be quite directly assimilated by some plants. In determining the "decay capacity" of a soil, a sterilized solution of peptones is inoculated with the soil and allowed to stand for a number of days in an incubator. The extent of decay is then determined by adding magnesia to the peptone solution and distilling off the ammonia by heating the mixture. The ammonia that is evolved is conveniently collected in sulphuric acid.

While a great many organisms can break down organic material with the formation of ammonia, there are only a few, so far as is known at present, that can convert the ammonia into nitrites and finally into nitrates. The classes of bacteria that can accomplish this were discovered by a Russian bacteriologist, Winogradsky, in the early nineties of the past century. The first class, the nitri-bacteria, attack the ammonia compounds, transforming these into nitrites. The second class, the nitro-bacteria, work on the nitrites, the end products being assimilable nitrates. As the nitri-bacteria can work only on ammonium compounds, the formation of ammonia appears to be a necessary phase in the development of nitrates in humus soil. Other denitrifying bacteria are usually found in humus soil, but under normal circumstances the nitri- and nitro-bacteria are much more active.

According to Hesselman, the sources from which the nitrogen forest soils is derived are as follows:

A. Decomposing litter. The nitrogen in this way is augmented by that obtained from the atmosphere and fixed by legumes, alder trees, and other plants.

B. Fungi and bacteria in the soil which have the power of assimilating nitrogen and which break up the organic compounds in the soil to obtain needed energy for this process of assimilation.

C. Ammonia and nitric acid precipitated from the atmosphere by rain-water.

In natural forest soils the factor described under B plays the greatest rôle. Losses of nitrogen from the soil occur in the following way:

A. Through the carrying away of soluble nitrates in the ground water.

B. Through the activities of denitrifying agents.

C. Through the removal of timber from the forest.

Previous researches on the formation of nitrates in forest soils have followed three rather distinct lines of investigation: (1) Earth samples have been examined to determine the occurrence of nitrate-forming bacteria; (2) the nitrate-forming capacities of the earth samples have been determined, and (3) the nitrogen content of trees and plants on different sites has been investigated.

Hesselman has made a number of detailed studies in different forest types, making use of all methods of investigation previously proposed, and from these studies he reaches the following conclusions:

The mild humus of beech forests contains, distributed throughout its entire portion, nitrate-forming bacteria, as well as denitrifying bacteria. Herbs and grass on such soil also contribute a considerable supply of nitrates. Earth samples on such soils can by storing form considerable amounts of nitrates.

Coniferous forests with a mossy ground covering are characterized by the absence in the humus of bacteria that can change ammonium sulphate into nitrates. Denitrifying agents are normally absent. Potassium nitrate is not found in the tissues of plants constituting the ground cover. The nitrate requirements of such forests must be satisfied by some means other than the assimilation of nitrates.

Nitrogen is changed into nitrates in several different kinds of natural soils. It is characteristic of the nitrate-forming soils that the formation of the humus takes place under the influence of electrolytes or mineral salt solutions. In such soils the formation of mild humus is hastened by insects and earthworms, which mix the humus with the ground water. The formation of humus on sites where the mineral-containing ground water is rapidly drained away gives rise to humus forms in which the nitrogen is not changed to nitrates. On account of its physical formation, mild humus becomes nitrated, while raw humus does not. In many situations the nitrification is so rapid that a considerable supply of nitrogen becomes stored up in the tissues of the plants composing the ground cover. This is especially true in close stands of beech, elm, oak, ash, alder, and especially in situations where the soil is penetrated by rapidly running water. Even in the highest mountain regions the ground cover in such situations contains a considerable supply of nitrogen. In meadows covered with shrubs and in spruce forests where the ground cover is herbaceous, the nitrogen of the humus is changed into nitrates, though the ground cover does not usually contain an accumulation of nitrogen. Plant colonies on bare mineral soils are often made up of nitrophilous plants, which store up nitrates in their tissues. In coniferous forests where the ground cover is composed of lichens and mosses, the nitrogen is not converted into nitrates, but the decay of litter terminates with the formation of ammonia and ammonium compounds.

Earths in the process of nitrification often have an acid reaction. Such earths often can convert ammonium sulphate into nitrates only very slowly, and denitrifying agents are usually quite generally distributed through them. Natural earths in the process of nitrification can by storing form just as large or larger amounts of nitrates as common agricultural soil.

Nitrification is influenced to a marked degree by the earth-forming processes, as well as by the climate. As the extent of nitrification has a strong influence upon the composition of plant colonies on a soil, the earth-forming factors will in many cases have a decisive influence upon their composition. Lime in the soil, as well as ground water containing dissolved calcium carbonate, assists nitrification. Similar forest trees grow more rapidly on soils where the nitrogen is converted into nitrates than where it is not. By proper forest management it should be possible to handle many forests in such a manner that nitrates will be formed in the soil, resulting in a decided increase in the amount of timber produced; but even on soils where nitrates are not formed excellent yields of pine and spruce can be obtained. In the latter case the rate of growth seems to be quite proportional to the rapidity with which ammonia is formed in the soil, and even here the soil-forming processes can be accelerated by proper forest management.

B. L. G.

Commission of Conservation of Canada. Report of the Eighth Annual Meeting, held at Ottawa, Ontario, January 16 and 17, 1917.

This contains reports of the committees on Forests, Lands, Minerals, Public Health, Waters and Water Powers, and Fisheries, Game and Fur-bearing Animals. In addition, there are a number of addresses, delivered at the annual meeting, dealing with different aspects of the conservation situation in Canada. The annual address of the chairman, Sir Clifford Sifton, gives an admirable general survey of the whole situation and points out the various directions in which further improvements are needed.

Co-operative forest protection is the subject of a paper by Henry Sorgius, manager of the St. Maurice Forest Protective Association. The classification of crown lands in New Brunswick is described by P. Z. Caverhill, director of Forest Survey, whose position has since been taken by G. H. Prince upon Mr. Caverhill's return to the British Columbia Forest Branch.

The report of the Committee on Forests, presented by Clyde Leavitt, Chief Forester for the Commission, discusses briefly the present situation in each of the provinces of Canada, reports progress made along forestry and fire-protection lines during 1916, and points the way toward further needed improvements. One feature to which reference is made is the extreme shortage of trained foresters in Canada, due to the heavy percentage of enlistments for overseas service. Notwithstanding this, notable improvements have been made, to which there is reference at length in the report.

PERIODICAL LITERATURE

FOREST GEOGRAPHY AND DESCRIPTION

Siberia's Forests

One of the Canadian Trade Commissioners, writing from Omsk, expands on the timber resources of Siberia, in the belief that Siberia contains a large supply of exportable material which may come into competition with Canada. There is, in our opinion, no immediate, or even near, future likelihood of such competition to be feared, and the commissioner recognizes some of the difficulties, which lie mainly in the absence of means of transportation, lack of labor, and untoward water conditions. When attempting to describe the forest-forming species, the commissioner finds himself in an inextricable tangle, mixing up pines and cedars, spruces and firs, so that no intelligible distinction is possible. The statistical information must also, like all Asiatic Russian data, be taken with caution.

"The forest area of Asiatic Russia has been roughly estimated at 853,000,000 acres. The State owns the bulk of the forests of this region, the area amounting to 642,000,000 acres, of which 39 per cent is classed as rich forest lands. In addition the forest possessions of the Imperial Cabinet have comprised an area of 54,000,000 acres, chiefly in the Altai district. These forest lands will now probably be converted into national property and more attention devoted to the exploitation of their timber wealth. Large tracts of forest land also belong to the Cossacks, particularly along the Amur River, in eastern Siberia.

"The largest forest areas of Asiatic Russia are in the western and eastern regions of Siberia. It is estimated that in that part of Siberia which lies west of Lake Baikal there are 465,000,000 acres of virgin forest, and eastern Siberia, while not so richly endowed, has sufficient timber to supply the requirements of foreign markets for many years to come. A large part of the forest area of Siberia is still unexplored, the resources in number of trees, species, and value being unknown. Thus it is estimated that only about a quarter of the whole area had been either wholly or partially investigated by the year 1915."

So far the cutting has been done mainly for local demand, except in eastern Siberia, where an expert trade via Vladivostok and other ports to Great Britain, and for inferior kinds to Japan and China, and also Australia, has been developed.

Weekly Bulletin, Department of Trade and Commerce, Vol. XVII, No. 711, 1917, pp. 541-545.

SOIL, WATER, AND CLIMATE

Forest Influences in India

Through *Indian Engineering* we are made aware of the fact that the government of India has lately made a most comprehensive canvass from province to province throughout India and Burma to ascertain what experiences have been had regarding the influence of forest cover on rainfall and streamflow. The results have been published in a note (where?) by M. Hill, Conservator of Forests, Central Provinces.

One very common illusion is dispelled by this inquiry, namely, that there have been noticeable climatic changes in India during the last 50 years. Rainfall is very variable and experiences periodic increases and decreases; as a whole, it depends on factors outside of the country, but is affected within the country by local conditions. The effect of forests is small, increasing it, according to Dr. Gilbert Walker, over them at the outside by 5 per cent, and it remains doubtful if areas outside the forest are affected at all. The water table was found to fluctuate with the rainfall.

The inquiry did not bring evidence that, on the whole, the flow of rivers and streams was less equable, that floods were shorter in duration and more violent, and that streams dried up more quickly. Yet actual forest destruction in catchment basins of individual rivers and streams was observed as producing damage. This is reported from the Punjab, Bengal, and Assam. In other cases, where no such damage is observed, it may be questioned whether deforestation has taken place.

In certain localities startling evidence of forest denudation is, however, furnished. "It might be taken as certain that in the absence of any definite policy of conservation, Chota Nagpur and many parts of Orissa would, to the irreparable ruin of their prosperity, at no distant date be stripped of all growth except worthless shrubs." Of the southern Shan States, and of the Myelat Plateau in particular, it is stated that in pursuance of the practice of shifting cultivation the pine and oak forests have been cleared, with the result that nine-tenths of the plateau now consisted of bare open downs covered with short grass and bracken fern.

"As a consequence the water supply had become scarce and the soil no longer had the power to hold large supplies of moisture and so to regulate the flow of water in the streams. During the rainy season the latter were subject to very sudden and violent floods, which subsided as quickly as they rose, and the water flowed either into the large Jule Lake or down to the plains of Burma, leaving the beds of the streams almost dry. The country was also cut up, as a result of these violent floods, by very deep ravines, having vertical banks, similar to the canyons found in the arid parts of North America. The soil on the plateau was a marvelously rich one, and with a good water supply the value and extent of the crops would increase tenfold."

The reporter concludes: "It may now be said to be established that, apart from their intrinsic uses, forests have an influence generally beneficial to a country."

Forests and Rainfall. The Indian Forester, September, 1917, pp. 419-425.

MENSURATION, FINANCE, AND MANAGEMENT

Forest Taxation in France

An interesting plea for a reform in the present method of forest taxation in France is presented by "R. F.," who is stated by the editors to be one of the most distinguished Deputy Conservators in the country. He points out that the present method of taxation is mathematically incorrect, since it is based on the assumption that if a given forest produces in n years a total revenue equal to R, it produces an annual revenue equal to $\frac{R}{n}$, while as a matter of fact the annual revenue, in accordance with the usual compound interest formula, is actually equal to $\frac{R}{1.0p^{n} - 1}$. The injustice of this method in the case of unregulated stands is illustrated by three practical examples which are summarized in the following table. The owner in each case is assumed to make a single clear cutting at the end of the rotation and the rate of interest is assumed to be 3 per cent:

	Rotation (n)	Total revenue per hectare (R)	Annual revenue per hectare		Excess of assumed over actual annual revenue	
			Actual $\frac{R}{(1.0p^{n}-1)}$	Assumed $\left(\frac{R}{n}\right)$		
	Years	*Francs*	*Francs*	*Francs*	*Francs*	*Per cent*
Coppice..........	20	600	22.33	30	7.67	34
Pine high forest...	30	5,000	31.53	50	18.47	59
Broadleaf high forest..........	100	6,000	9.88	60	50.12	507

It is evident from this that in stands having a periodic yield the assumed annual revenue, which is used as a basis for taxation, exceeds the actual annual revenue by from 34 to 507 per cent, depending on the length of the rotation and the amount of the final return.

In the case of regulated stands managed so as to secure a sustained annual yield this discrepancy would not exist and the actual and assumed revenue would really be equal. Thus, if the hectare of coppice is thought of as being divided into 20 equal parts, with an even gradation of age classes running from 1 to 20 years, the annual cut would obviously yield a revenue of $\frac{600}{20}$, or 30 francs. The author points out, however, that this annual return is due entirely to the fact that the owner has had the foresight to practice forest management and to secure such a gradation of age classes as to make an annual cut practicable. In other words, he argues, the productive forest capital consists of two distinct parts—the soil and the growing timber—each of which contributes its share to the annual revenue. The part produced by the soil is considered as being the annual equivalent of the final yield when a single clear cutting is made at the end of the rotation, and the remainder is considered as being produced by the growing stock. In the case of the coppice stand already mentioned, for instance, the annual revenue produced by the soil would be 22.33 francs and that produced by the growing stock 7.67 francs, while in the case of the broadleaf high forest the revenue produced by the soil would be only 9.88 francs and that produced by the growing stock 50.12 francs.

The burden imposed by the present method of taxation obviously becomes increasingly heavy as the rotation increases in length, particularly in the case of unregulated stands. As a direct result of this the area of high forest under private ownership has decreased steadily, except in certain regions where conifers are grown on a short rotation for mine props, until today the State is almost the sole producer of large-sized timber throughout the greater part of France. The State forests have accordingly been drawn on very heavily for material needed for the national defense, and the forest resources of the entire country have in fact been seriously depleted.

As one means of assisting in the restoration of the French forests, which will be so imperatively needed after the war, and especially of encouraging the growing of high forests for the production of large-sized material, the author advocates a reform in the present method of forest taxation. He suggests that in the case of forests having a periodic yield the land tax be based on the equivalent annual revenue as determined by the formula $\frac{R}{1.0p^n - 1}$. In regulated forests having an annual yield that portion of the annual revenue which he regards as being produced by the soil would be subject to a land tax in the same way, while the remainder would be subject only to a personal-property tax, which is considerably less than the land tax. Thus, if a broadleaf high forest is capable of producing a periodic yield of 6,000 francs per hectare every 100 years, it would be subject to a land tax on the basis of an annual return of 9.88 francs, while if the same forest were managed so as to produce a sustained annual yield of 60 francs per hectare, it would be subject to a land tax on the basis of an annual return of 9.88 francs and, in addition, to a personal-property tax on the basis of an annual return of 50.12 francs.

There would seem to be considerable question as to the validity of the distinction which the author makes as to the character of the return from forests having periodic yields and those having sustained yields. In the first case he attributes the yield entirely to the soil and in the second case both to the soil and to an accumulation of wood capital. As a matter of fact, from the very nature of the forest, a considerable accumulation of wood capital is necessary in either case before the final product can be harvested, and toward the end of the rotation this accumulation is actually greater in the forest having a periodic yield than in that having a sustained annual yield. The real distinction between the two lies in the fact that in the first case the wood capital is kept practically constant, while in the second case it is subject to great variations.

There is no doubt that the proposed reform would increase the returns of those owners who handle their forests on a sustained annual-yield basis, and would thus tend to encourage the practice of forest management. The encouragement would be still greater, however, if the proposed personal-property tax were omitted, and the man who practices intensive forestry thus put on the same footing as the man who does not, so far as taxation is concerned. Otherwise the man who shows sufficient initiative and public spirit to manage his holdings so as to secure the maximum return from them is really penalized to a certain extent for doing so. The proposal is probably of chief interest to foresters in this country because of its recognition of the soil and the growing stock as distinct parts of the forest capital; of the vital importance of maintaining the national supply of wood by the practice of forestry; and of the effect of the system of taxation employed in doing this.

S. T. D.

Note sur l'opportunité d'une réforme de la méthode d'imposition des propriétés boisées. Revue des Eaux et Forêts, Vol. LV, No. 10, October 1, 1917.

UTILIZATION, MARKET, AND TECHNOLOGY

Naval Stores Production in Germany

With the tremendous increase in freight rates to Sweden, the gathering of naval stores in that country has developed into an industry producing more than 5,000 tons of resin annually. German terms were formerly used in Swedish literature upon this subject; but G. Lundberg, a Swedish government investigator, refuses to use these longer, and coins the following terms: "Harts"—rosin; "Flytande kåda" or "balsam"—resin; "Töre"—resin in pitch streaks; "Skrapkåda"—scrape; "Vilokåda"—natural resin exuding from stems; "Becka" or "Kådbecka"—turpentine orchard; "Katning"—cornering or cutting of faces; "kantkatning"—chipping. The purpose of the article is to present for the benefit of Swedish operators the methods used in Germany.

Germany uses 100,000 tons of rosin annually. At the outbreak of the present war, however, there were no stocks of rosin in that country. From 1860 to 1870 about 200 tons of rosin were produced in Sachsen, but immediately before the war no naval-stores industry existed in Germany. After the war had begun, the gathering of natural resin became a small industry, and intensive experiments in turpentine orcharding were at once started. In the fall of 1916 a small amount of spruce rosin was imported from Sweden, but in the spring of 1917 Germany had succeeded in producing a sufficient supply of rosin and turpentine for her own use.

The gathering of the resin is controlled by a government bureau, *Der Kriegsausschuss für pflanzliche und tierische Oele und Fette.* This committee has succeeded in developing manufacturing methods which eliminate the use of rosin in many industries. Economies in the use of rosin in paper manufacturing were begun even before the war, when the price of rosin rose about 6 per cent, and the reduced consumption made the effective increase only from 1 to 2 per cent, with no sacrifice in the quality of the paper. No news paper made in Germany is now sized with rosin, and even high-grade papers made by the war emergency process (the Zellkoll-Amal method) contain no rosin. The resin division of the bureau is headed by a forester, Dr. G. Munch. Local forest supervisors have charge of the gathering of the resin, which is distilled in previously existing fish-oil extraction plants, from which it is distributed to the industries under supervision of the bureau. The resin is obtained from common pine and spruce. Pure stands of pine, avoiding stands with an understory of spruce, are orcharded. Full crowned, rapidly growing stands, with no shade-producing undergrowth on southern or warm exposures give the best yields. To avoid the loss of timber in the butt log, timber that is to be cut within a ten-year period is selected.

The "Grandel" method of orcharding is commonly used, though the "swallow nest" and "boring" methods are also used to a limited extent. The cup-and-gutter method was abandoned, due to the difficulty of getting a sufficient supply of cups. The "Grandel" method is essentially similar to the American boxing method, but the faces are cut much narrower and there is only one horizontal streak at the top of the face. Three to five faces are cut on each tree, leaving at least 20 cm. of bark between each face. On leaning trees the faces are cut with the aid of a plumb-line. The faces are about 12.5 cm. wide, and when first cut extend about 15 cm. above the boxes, which are placed as near the ground line as possible to avoid the destruction of timber in the butt log. The outer edges of the boxes are extended with strips of galvanized iron about 4 cm. wide, wedged into grooves that are cut in the edges of the boxes. The season for pine begins about the first of May and continues until the early part of October. The faces and boxes are usually cut several weeks before the season begins, to allow traumatic resin ducts to form before the resin begins to flow. As soon as about a teaspoonful of resin is produced in a day, chipping begins. In chipping, a narrow strip about 0.5 cm. wide is cut from the streak with a razor-edged tool, as it has been found that the use of a dull tool will greatly reduce the yield. Care is taken to make a slanting cut on the streak, so that as many ends of resin ducts as possible are exposed.

Fresh streaks are cut every other day, due regard being taken of weather conditions.

In the "swallow nest" or "svalbo" method a crescent-shaped strip of galvanized sheet iron is grooved into the face, forming a box that is moved up from time to time as the face lengthens, so that a lesser amount of turpentine will evaporate as the resin trickles from the streak to the cup formed by the sheet iron.

In the boring method a hole is bored into the tree near the base and the lower end of the face is constricted to conduct the flowing resin into this hole, from which it is collected with special spoons.

The bureau has found that it is better to work a smaller area intensively than a larger area with more extensive methods. The trees are faced and boxed by able-bodied forest rangers, but chipping, dipping, and scraping are done by women, and particularly crippled men, who do piece-work under a bonus system, earning as much as 30 pfennings per hour.

Spruce resin is gathered by the "Vögtländska" (Voightland) method. Trees that are approximately sixty years old and that are to be cut within ten years are chosen, though no trees that are to be cut within several years are orcharded. The production of spruce resin increases from year to year, reaching a maximum in about three years. The yield during the first year is low. Resin is produced in the greatest quantities by trees that have good crowns and that are located on warm and protected exposures. When the bark begins to "slip" in the spring the trees are faced. This can be done at any time from the end of April to the latter part of July. In facing, a longitudinal cut 2 meters high, beginning about 60 cm. above the ground, is first cut with an ax. Parallel with this cut and about 2.5 to 3 cm. distant, similar cuts are made on each side of the first cut, connecting at the lower end with the first cut. The bark is then peeled from the area between these cuts. Additional faces are cut on the same tree, leaving a strip of bark from 12 to 15 cm. wide between each face. Some trees may therefore have three or four faces. Faces on the south side of the tree, where the sun strikes during the hot part of the day, are avoided. At the end of the season the resin that has accumulated on the faces is scraped off very carefully and collected. The resin is gathered only once each year, usually before the cold weather of winter arrives. In the gathering of spruce resin the work is chiefly done by women, who are paid 22 pfennings per hour.

In the northern part of Germany and in large areas in Poland the resin is principally obtained from pine, but in southern Germany large spruce stands are orcharded. As the pine resin contains more turpentine than that obtained from spruce, it is more valuable.

Intensive experiments in the production of resin are still under way in Germany. A modification of the Gilmer turpentine cup system has given promising experimental results. The following specific research problems are under investigation at the present time:

1. The effect of the depth of faces and streaks.
2. Careful measurements to determine the degree in which the production of resin increases during the first weeks and months after facing and to what extent the failure of certain individual trees to produce sufficient amounts of resin consists.
3. Experiments to determine the most suitable number of faces on a single tree and the effect of a greater or lesser number of faces on the ultimate gross production of resin.
4. A continuance of experiments to determine the degree in which weather conditions influence the production of resin.
5. A continuance of experiments to determine the proper interval between chipping in stands of different origin and different age classes.
6. The effect of site upon resin production.
7. The influence of crown size upon resin production.

The effect of turpentine orcharding upon the strength and durability of the wood was determined by the bureau to be negligible. Seeds from trees that have been orcharded, however, produce seedlings of inferior size and vitality.

B. L. G.

Tysklands nuvarande hartsindustri. Skogsvardsföreningens Tidskrift. July-August, 1917, pp. 735-762.

Use of Wood Oils in Flotation

The development of the flotation process for recovering metals from ores has given rise to new uses of wood for the production of oils to be used in this process. In this connection we call attention to the investigations of the Canadian Forest Products Laboratories, carried on by Gilmore and Parsons, reported in detail, with extensive tabulations, in the *Monthly Bulletin of the Canadian Mining Institute*, on over 40 pages.

The conclusions are: (1) Crude hardwood oils, the supply of which is abundant, can be substituted for pine oil as a selective frothing agent in the commercial flotation of cobalt area silver ores. (2) Heavy hardwood creosote oil and acid (creosote) oil give equally satisfactory results, and a mixture of these two oils in proportions as produced is recommended as a standard hardwood flotation oil. (3) Ketone residue in the crude state can also be considered a satisfactory flotation oil for commercial use on cobalt area silver ore and other ores.

For those who are not familiar with this newest, now widely discussed, process of recovering metals from crushed ore, a few sentences will make it clear:

The flotation process for the concentration of ores is a method by means of which one or more of the minerals in the ore (usually the valuable ones) are picked up by means of a liquid oily film and floated at the surface of a mass of fluid pulp. Here they are separated from the other minerals, which remain immersed in the body of the pulp. The importance of flotation lies in the fact that it is primarily a "slimes process," by means of which the particles of valuable mineral, too fine for efficient gravity concentration, are saved, with a high percentage of recovery. Recoveries in the mills treating low-grade copper sulphide ores have been advanced 10 to 20 per cent by the installation of the process, and similar increased savings have been accomplished by the same means in mills treating sulphide ores of zinc and lead.

Monthly Bulletin of the Canadian Mining Institute, October, November, 1917, pp. 856-875; 927-949.

MISCELLANEOUS

Prickly Pears as Food

The propagation of spineless prickly pears has been the subject of experimentation for several years by J. H. Maiden, botanist at Sydney, South Australia. These experiments are now abandoned, having proved that the opuntics in their quality of drouth resistance are unequaled, but that as a fodder plant its cultivation cannot be recommended in the district of the experiment. The fruit, as an article of diet, has little or no value, and even the drouth resistance is a negligible virtue, possessed at nearly the same degree by such plants as old man saltbush. The liability to revert to spines was not very marked and not sufficient to be harmful to stock. The fruit, however, has always been very spiny. A table gives detail for twenty varieties cultivated.

The Agricultural Gazette of New South Wales, October, 1917, pp. 740-742.

EDITORIAL COMMENT

Forestry after the War

What effect will the war have upon forestry?

As every one knows, the forests are playing a strikingly prominent part in the prosecution of the war. In this age of coal and iron, wood is being sought more eagerly and used more extensively than ever before. In the trenches, on the road, in the air, in the shipyard, in the munition factory and chemical laboratory, in the building of cantonments, and in the fireplace at home, wood has become a dominant factor.

In countries with limited forest areas, such as England, France, and even in neutral countries like Switzerland, Sweden, and Norway, the war-time demand for wood has made deep inroads into timber resources. It has also disorganized, if not depleted, the forests of the Central Powers.

This demand for wood is not going to decline with the termination of the war. The reconstruction of the devastated portions of France and Belgium, the rebuilding of the peace industries, will call for vast quantities. The United States, Canada, and Russia, still possessing vast forests, will have to meet this world's shortage in timber.

What deductions suggest themselves as a result of these outstanding facts?

The long-delayed plans for extensive reforestation in England will now become a reality.

France and Belgium will feverishly begin the upbuilding of their depleted or disorganized forests.

The heavy cuttings in Norway, Sweden, and Switzerland, induced by the high prices paid for timber by the belligerent nations, will be restricted and the remaining diminished supplies will be husbanded with greater care. Switzerland, fearing the depletion of its privately owned forests, has already placed stringent regulations for the cutting of timber during the war. These restrictions will unquestionably become permanent.

It is only reasonable to expect that a similar policy will be adopted with regard to the forests of our own country. A resource which promises to prove a decisive one in winning the war will never again be allowed to be destroyed or devastated. Our army and navy, which more than any other branches of our Government have come to realize the value of forest products, will probably be among the first to place the timber lands in their control under forest management. The tendency in this direction is shown in the case of the recently acquired Gunpowder Neck Proving Ground, a forest tract of about 35,000 acres, which it is planned to put in charge of a forester and manage as a permanent resource.

Farm forestry will be put on the map. The value of the farmer's woodlot as a source of emergency fuel and of a supply of ordnance wheels, airplane propellers, and other war material will forcibly drive home to Government and State agencies concernd with the welfare of the farmer the importance of the woodlot as a national asset. The county agents who are now taking an active part in the wood-fuel campaign throughout the country will after the war become the most effective agencies in the improvement of the farmer's woodlot.

The value of the forests will stimulate interest in planting on the part of the State and private individuals.

If, with the diminished world supply of timber and higher prices for lumber, private timber owners are still unable to safeguard this national asset from further destruction, enlightened public opinion may demand some form or other of Government regulation of timber cuttings on private holdings. The lumbermen themselves, in the face of the lessons taught by the war, will be more friendly to such Government regulation; and the Government, having learned how to handle big enterprises, such as the equipment of a large citizen army, running of railroads, control of food production, and other national necessities, will be better prepared to undertake such regulation.

With the regulation of private timber holdings there must come also more intensive forest management in the National Forests themselves, which are merely a part of the timber resources of the country.

Other factors which augur well for the better handling of our forests in the future are the forest regiments now in France. In the foresters and lumbermen who have worked shoulder to shoulder and have learned first hand the French methods of forest regulation, the country will have a body of men particularly fitted to adapt the utilization of our forests to the changed needs of the time.

Thus on the battle fields of Europe is being fought out not only the future democracy of the world, but also the material foundation of all democracies—the wise use of the natural resources.

R. Z.

"Denudatics"

Our friends have often in the past been unfortunate in the extravagance of their claims for the benefits of forest cover and for the disasters following deforestation, which brought us the sobriquet of "denudatics." We had hoped that the malady had passed away and that the discussion of the forest influences had finally come into saner channels. We were therefore sadly disappointed to see a revival of these extravagances in a pamphlet issued by the Texas Department of Agriculture, prepared by a member of the Scientific Society of San Antonio, entitled "Deforestation and Reforestation as Affecting Climate, Rain, and Production."

We had expected in a publication issued under such auspices to find new data on this controversial subject; instead we found a virulent outbreak of the disease—extravagance in the worst form. Surely, the author is a worthy member of the denudatics.

Here, in vivid, exuberant, and persuasive language, it must be confessed, are dished up the discredited historic evidences of Asia Minor, Mesopotamia, and all the Mediterranean countries, not forgetting the Sahara, as a result of deforestation. Indeed, it is claimed that *"all* deserts have been man-made." We are assured that: "It is axiomatic with scientists (?) that no country was originally a desert." "It is *certain* that the arid lands we have in North America have been made so by the extermination of the trees through forest fires and possibly the destruction of trees for fuel and clearing for cultivation by the great prehistoric agricultural people who preceded the nomadic Indians." And these preposterous theories are elaborated on legendary basis. Climatology is "not in it"!

The author is not happier in his physiological exposé. "Trees are inducers of rain. . . . When the air is moist, they absorb the dampness and thriftily store it away in capacious reservoirs of millions of tubes in the trunks and limbs of the trees, and when parched nature looks upward and prays for water, like Dives did to Abraham and Lazarus, these same little 'miracles of design' draw on the supply of water in the tree that they have stored away and that the rootlets have absorbed from the earth and send the precious liquid forth into the air, an unseen exhalation to be condensed by the atmosphere and to fall in benedictory showers or refreshing dew. . . . Other trees that need more water will, if growing near by, absorb it from these generous neighbors—as, for example, the magnolia will flourish at Los Angeles, Cal., if near other trees, but will die if it be planted alone."

The plant physiologist take notice!

The mistaken sponge theory of the forest floor and the discarded health-exhaling oxygen theory, of course, also play a rôle.

We regret that the evidently good intentions of the author and the publisher to educate their people in an appreciation of the value of a forest cover have misled them into excess. We only hope that the article will not fall into the hands of our antagonists, whose mirth it would justly provoke.

The professional forester, nevertheless, like any other philosopher, will hold that forest influences exist in all directions claimed, but we are not sure as to degree and extent, and besides there are other factors involved which it is not fit to overlook.

In this connection we call attention to the contribution to this question furnished by the Indian Government, briefed on page 122 of this number.

B. E. F.

Progressive Step by Western Pine Manufacturers' Association

Early in December the Western Pine Manufacturers' Association announced its acceptance of the basic eight-hour day. At the same time it was announced that about 20 men would be sent to the University of Washington this winter to study modern systems of labor employment and management and efficiency management in general. There have been, here and there, minor examples of modern industrial management in the lumber industry, but this is the first acceptance of these enlightened principles by an important section of the industry. For the most part forest industry, though often equipped with efficient machines, due to the enterprise and activity of the machinery houses, has otherwise struggled along with the industrial methods of a half century in the past. The discovery of modern industrial management was bound to come eventually, but we believe in this case the day was hastened by an efficient association secretary (who is a trained forester), by contact during the past few years with the very efficient leaders of the Missoula district of the Forest Service, by the lumber industry study conducted by the Service, and by contact of late with economists connected with the State councils of defense, who have been making a careful study of labor conditions, as a result of strike troubles of the past few months.

Altogether the announcement is one of the most important affecting the lumber industry in recent years. If the adopted policy is intelligently carried out, as seems to be assured, it cannot fail to result both in decreased cost of lumber production and in better conditions for labor. The adoption of efficiency management means, when faithfully carried out, the replacement of prejudice by scientific inquiry into every factor that affects the industry. The methods of labor management, selling management, finance, and supply of raw material must therefore receive careful scrutiny. If this scrutiny goes deep enough, it must inevitably reveal that in labor management permanence of industry in each locality is of prime importance, in order that workmen may have the normal family life, now impossible in most of our Northwestern logging industry. In the field of sales management it must reveal that the expense of efficient sales organization will be better distributed if supplies of forest products are permanent, making possible constant growth and progress within established organizations. It may also reveal that the only safe limitation of output, which is necessary to prevent destructive competition and too merciless price cutting, is limitation at the source of supply of new material—in the forest this means limitation to the continuous productive capacity of each forest unit. Likewise finance and supply of raw material are intimately related to forest policy. Innumerable sawmills have been built in the past subject to a depreciation rate of 10 to 20 per cent, due to early exhaustion of raw material. In most cases the building of fewer mills would have resulted in a longer operating life for each mill built and saved vast depreciation losses. Depreciation due to exhaustion of raw material can be completely eliminated by limiting mill-building in each locality to what the forests of that locality will produce continuously and then working those forests for continuous production. These statements indicate only a few ways in which scientific management of the lumber industry must lead toward the proper handling of the forests for continuous supplies of raw material, just as the far-sighted U. S. Steel Corporation has provided for raw material for a century or so into the future, in order to be certain its plant investment need not be written off the books for want of raw material—a thing that happens every day to one or another of our sawmilling concerns. Of course, we do not hold that continuous production will necessarily be carried on by lumber companies themselves. We do hold that this policy must appear essential to enlightened concerns, and such concerns should see to it that if forest production is not financially practicable for them the lands will get into hands for whom it will be practicable—in many cases the Federal Government, in others the State, and in still others perhaps some large private corporation.

Under such a policy it would be obviously foolish to take the wrecking value of the forests at the first cutting, as at present, and thereby cause an unnecessary expense of $5 to $25 per acre for re-establishment of the forest, as it must eventually be. We could write at length on the possibilities opened by this enlightened policy, but the points above must suffice to show the hopeful future under it.

Muskrat Farming

In these times of reappraisement of our natural resources—finding new materials, substitutes, and extensions of use of old materials—the editor recalls his definition of a weed as a plant whose use has not yet been found out. We had supposed that the muskrat was falling under this definition, but are agreeably surprised by the publication of the Bureau of Biological Survey (Farmers' Bulletin 869, U. S. Department of Agriculture), devoting some 20 pages to the discussion of this animal. We learn from this that the muskrat is not only an important fur-bearer, but a palatable food, found marketed as such, under the name of "marsh rabbits," in Philadelphia, Baltimore, and Wilmington, at 10 to 20 cents.

It plays, however, a greater rôle for its fur, especially in view of the steadily decreasing fur resources of the States.

"The muskrat has been one of the chief factors in maintaining a high total value for our annual fur production, and in commercial importance now heads the list of fur-bearers of the United States." While other small fur animals have grown scarcer, muskrats have rather increased, and that in spite of increased marketing, which before the war in London alone had grown to over 10 million skins, and it is stated that with proper protection during the breeding season from 10 to 12 million pelts can be taken annually in North America without depleting the supply.

Moreover, muskrat farming is already a prosperous business, adding new values to marsh lands, several examples being cited of profitable farming.

B. E. F.

NOTES

France Creates a General Committee on Wood

On July 3, 1917, President Poincaré, of France, created a General Committee on Wood (Comité général des Bois) as a central agency to co-ordinate and control all matters relating to the utilization of wood. More specifically, the duties of the committee are to ascertain the needs of the various government departments and of the general public; to determine the possibilities of satisfying these needs in the best interests of the entire nation; to promote the rational utilization of the forest resources of the country; to decide as to the relative importance, both in France and other countries, of purchases, transportation, and manufacture; and to control importations, exportations, and accumulations of stock.

The Minister of Agriculture, or his delegate, the Director General of Waters and Forests, acts as president of the committee. A representative of the Minister of Munitions and a representative of the Minister of Commerce serve as vice-presidents. In addition, there are 17 representatives of the various government departments having to do with the use of wood, three persons familiar with forestry, who are designated by the Minister of Agriculture, and four manufacturers or dealers in wood, who are designated by the Minister of Commerce. Each of the representatives of the various government departments is allowed the assistance of a technical expert who can attend the meetings of the committee in an advisory capacity

The main committee includes also a permanent subcommittee, to which it delegates such of its powers as it deems advisable. The chairman of this subcommittee is the representative of the Minister of Munitions who serves as vice-president of the general committee. The other members are the representative of the Minister of Commerce who serves as vice-president of the general committee and the representatives of the Minister of Agriculture, the Minister of War, the Food Controller, and the Under-Secretary of State for War Manufactures.

The deliberations of the committee are secret and can be divulged only on its express authorization. Such proposals as it may make are submitted for action to the ministers of the particular departments involved. It is the duty of the subcommittee to prepare the decisions of the main committee and to see that they are carried out.

The newly created General Committee on Wood supersedes the General Committee on Forests which was established on May 4, 1917, and takes over such portions of the work previously handled by the Interdepartmental Commission on Woods, Metals, and War Manufactures as had to do with wood. The latter committee is hereafter to be known as the Interdepartmental Commission on Metals and War Manufactures.

S. T. D.

During the past year more than 500,000 forest-tree seedlings have been shipped from the Quebec forest nursery at Berthierville, P. Q. The provincial forester, G. C. Piché, reports that of these nearly 200,000 were white pine, 180,000 Norway spruce, 82,000 Scotch pine, 20,000 Douglas fir, 8,000 red pine, 7,000 white spruce, and 6,000 tamarack, the balance being made up of relatively small numbers of other species, mostly hardwoods, to supply the demands of farmers. The great bulk of the demand was, however, for the reforestation of burned-over non-agricultural lands. The Laurentide Company, Limited, and the Riordan Pulp and Paper Company were heavy purchasers of plant material from the provincial nursery, in addition to supplies secured from their own nurseries. The Perthuis seigniory also has purchased a large number of small trees from Berthierville annually during the past seven years.

To date the provincial nursery has shipped a total of more than 1,500,000 trees since its inception; of these, more than half have been supplied during the past two years. The demand for planting stock has become so insistent that the provincial forester announces the proposed extension of the capacity of the Berthierville nursery to 3,000,000 seedlings annually. Of these, the majority will be Norway spruce, which is believed to be the most suitable species for pulpwood production.

Scarcity and high price of imported fuel are given as the reasons for the recent development of Argentina's forest industries, the lack of economical means of transportation having previously retarded this development. Argentina's timbers are mostly of the hardwood variety and of little use for constructive purposes. Quebracho is the most widely known and generally useful timber, as well as tannin producer.

An annual output of 17 million dollars is reported by the Census of 1910 from 283 sawmills; 4 millions from nine Quebracho extract factories, and a capitalization of 8 millions for 100 forest-development companies, with annual sales of 5½ million dollars.

A stock company is being formed by Norwegian business men to take over the well-known Reynolds Lumber Company, in Petrograd, Russia. The name of the new company will be Edward Reynolds, Limited, and it will take over all the forest and other properties—sawmills, lumber yards, etc.—belonging to the old firm. The purchase price is $2,725,500.

A decision of the Supreme Court of Washington in the case of Carrie Sandberg *vs.* Cavanaugh Timber Company, on appeal, makes the owner of property upon which a forest fire starts liable for damage of a neighbor's property, no matter how the fire started and although he used some effort, but not effective, to stop the fire. The complainant lost her house by forest fire and the jury's award of $2,000 was sustained.

The North Coast Timber Company, of Tacoma, Wash., has a novel logging-camp equipment which consists of a railroad train of 17 cars with comfortable houses. Besides sleeping cars (11 by 42 feet), accommodating each 16 men in steel bunks, and sitting-room space, there are kitchen car, dining car, library car, bath and drying room, blacksmith and filing car. The whole plant is lighted by electricity and steam heated.

The proposed increase in grazing fees on the National Forests will not take effect the coming season, although in general the fees charged in 1917 were found still below the real value of the forage. Considerations of war needs explains this decision.

The plan to issue five or ten year permits, which would not be subject to reduction during the period for which they are issued except for damage to the range or violation of their terms, will also be held in abeyance.

The demand for an increase in meat production and the necessity for stocking the forest ranges to the extreme limit of safety makes the issuance of such permits inadvisable, according to Mr. Cecil, since with them in force forest officers would not be able to make certain readjustments and allotments which the present situation with reference to meat production may require.

The Division of Forestry of the University of California has moved into its new quarters in the recently completed Hilgard Hall, which is one of the buildings of the agricultural group. Hilgard Hall is a very large building, housing several divisions of the College of Agriculture. The Division of Forestry has ample quarters consisting of 22 rooms, most of which are very completely equipped. The rooms include a class-room, a large general laboratory for all undergraduate courses, three special research laboratories for forest utilization and wood technology, three small special laboratories for advanced students in other branches of forestry, a large logging engineering laboratory, drafting room, blue-print room, instrument room, herbarium room, lecture demonstration materials room, store room, club room, and six offices.

Two unique features of the equipment are the logging engineering room and the herbarium room. In the former various kinds of logging engines and machinery will be demonstrated by working models run by small motors. In the center of the room is a heavy plank floor above the regular concrete floor, on which the classes will get practice in rigging up working models of various cable systems and other logging devices. The herbarium room contains not only standard steel herbarium cases, but a long series of special display cabinets for 103 of the leading timber species of North America. To each species is devoted one entire vertical row of four compartments, protected by glass doors, in which are shown the flowers, seed, fruit, seedlings, and foliage in Riker mounts, and specimens of the lumber and bark. On a display space above the compartments are placed a map of the distribution of the species and a brief statement of the properties and uses of the lumber. Below the compartments are drawers for extra fruit and wood specimens. The classes will have free access to this collection for their dendrological work.

Notice has been received of the Fourteenth Annual Meeting of the American Wood-Preservers' Association, scheduled for January 22 to 24, 1918, at the Hotel Sherman, in Chicago. A number of interesting and valuable papers will be presented and the meeting should prove profitable to those who are interested in the subject.

SOCIETY AFFAIRS

In spite of war conditions, the annual meeting of the Society at Pittsburgh, in connection with that of the American Association for the Advancement of Science, was a success, qualified only by the absence of so many familiar faces. Under the circumstances, we were fortunate in having an attendance at the various sessions of from 16 to 18 members and friends of the Society. These were as follows:

F. S. Baker	R. S. Hosmer	E. N. Munns
J. E. Barton	R. C. Jones (Va.)	G. A. Retan
F. W. Besley	J. E. Kirkwood	H. A. Reynolds
O. M. Butler	C. F. Korstian	A. E. Taylor
H. M. Curran	H. N. Lee	I. C. Williams
E. H. Frothingham	L. H. Pammel	George Wirt
Miss Eloise Gerry	G. B. MacDonald	

The meetings, which were held in the Applied Design Building, Carnegie Institute, were run on schedule time. Of the twenty-two papers on the printed program, however, eight were not presented. This was regretted, yet it gave an added margin of time for discussion, of which full advantage was taken. As it was, one extra session, not previously provided for, was held.

The first session (Monday morning, December 31) was a joint meeting with the Ecological Society. The program was as follows:

The Significance of Transpiration in Forestry.....................C. G. Bates
Some Biological and Economic Aspects of the Chaparral..........E. N. Munns
Some Ecological Notes on the Forests of Southeastern Iowa...G. B. MacDonald
L. H. Pammel
Precipitation as a Factor Limiting the Distribution of *Pinus ponderosa scopulorum*..................................C. F. Korstian and F. S. Baker
Native Plants as Indicators of Forest Planting Sites...............F. S. Baker
Forest Distribution in the Northern Rockies....................J. E. Kirkwood
Height Growth as a Key to Site..........................E. H. Frothingham

In the afternoon the annual business meeting of the Society was held, with Professor Hosmer in the chair. Among the matters approved by the meeting or recommended for consideration by committees were: the indexing jointly of the volume of the Proceedings and the Forestry Quarterly up to the date of their consolidation; the appointment of Dr. Whitford as an editor in charge of tropical forestry on the Editorial

Board of the JOURNAL; the adoption of a standard basis of classification of the subject-matter of forestry; the consideration by the Society of ways and means of improving living and social conditions of woods workers, and the prohibition of all plant importations except those arranged by the Secretary of Agriculture.

The subject of most immediate interest was, of course, the fuel situation and the problem of substituting wood for coal on a large scale. It was therefore decided to hold a special session that evening for the discussion of Mr. Hawes' paper on this subject and possibly one or two other papers. A room was secured at the Seventh Avenue Hotel, where sixteen of the delegates had supper together and later read and discussed at length the following papers:

Increasing the Consumption of Fuelwood as a National Economy...A. F. Hawes
Forestry and Agricultural Development in the South............W. R. Mattoon

This meeting adjourned about 11 o'clock and the members separated to observe the end of the old and the coming of new year, each after his own peculiar custom when in a strange city.

The meeting resumed the next morning, a little behind schedule, in Room 208 of the Applied Design Building of the Carnegie Institute. The following papers were read and discussed during the morning:

Check Dams as a Means of Controlling Floods in Southern California...E. N. Munns
A Practical Reforestation Policy..................................G. A. Retan
A Word to the Members...Filibert Roth
Some Social Aspects of Forest Management..................Benton MacKaye
The Rôle of Artificial Regeneration in the Reinforcement of Hardwood Woodlots...Edmund Secrest
Some Wood Problems in War Time..............................O. M. Butler

Mr. Butler's paper was illustrated with two fine reels of pictures taken at the Madison Laboratory, and showing details of the everyday work there, in connection with the different testing processes, etc.

The last session convened at 2.15 p. m., January 1, when the following papers were read and discussed:

The Economic Basis of Recreation Forests.......................R. S. Hosmer
Native Vegetation as a Criterion of Site.........................C. F. Korstian
Aspen Reproduction in Relation to Forest Management............F. S. Baker

After directing the Secretary to express to Dr. Fernow the regrets of the members present at his inability to be present at the meetings, the second annual meeting of the Society, in connection with that of the

American Association for the Advancement of Science, was brought to an end.

It is expected to publish in the February number of the JOURNAL the formal annual reports submitted at the annual business meeting held in Pittsburgh. A report of the annual election is here given, in which it will be noted that two extra and temporary members have been elected to the executive council to take the places of those who are on active field duty with the Army.

RESULT OF 1917 ANNUAL ELECTION OF SOCIETY OF AMERICAN FORESTERS, DECEMBER 20, 1917

	Votes received by officer elected	Total vote cast for each office
President:		
F. Roth	96	184
Vice-President:		
J. A. Ferguson	99	179
Secretary:		
E. R. Hodson	141	179
Treasurer:		
A. F. Hawes	106	186
Executive Committee—		
5-year Term:		
J. W. Toumey	93	175
Temporary (in place of Mr. Greeley):		
H. H. Chapman	166	183
Temporary (in place of Mr. Graves):		
W. L. Hall	114	183

Formal announcement has been received from Mr. Robert B. Sosman, Corresponding Secretary of the Washington Academy of Sciences, that at the annual meeting of the Academy, on January 8, Mr. Raphael Zon was elected a Vice-President of the Academy, for the current year, to represent the Society of American Foresters.

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JOURNAL OF FORESTRY

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A WORD TO THE MEMBERS[1]

By Filibert Roth

A year ago Dr. Fernow sketched the "Situation." He did this accurately and without optimism or pessimism adding any undue colors.

Being a believer in optimism, permit me to add a few strokes of color and possibly a few points to this sketch.

Keeping in mind that the word "forestry" was not in the American dictionary as late as 1880, and that the technical journals of those days dubbed us "cranks" and called those who actually believed in Sargent's forecasts in the Tenth Census by the well-coined term of "Denudatics," the progress of the last 30 years is most extraordinary. Since our worthy Nestor in Forestry took up the difficult task of making a governmental agency for forestry, to plan its work and to outline the great forest policies of our country, and, together with Secretary Noble and Edward Bowers, to secure the passage of the greatest forestry act, the act which has put the United States in a front rank in forestry, so much has taken place in forestry that most foresters themselves scarcely realize the magnitude of the success. It bears repetition to say that the National Forests represent an area more than four times that of all the forests of the German Empire; that the U. S. Department of Agriculture has an organization covering this vast body of forests; that it offers timber by the hundreds of millions of feet; has accurate surveys of millions of acres; has built thousands of miles of roads, trails, phone lines, and, what is more than all, has won the respect and confidence of the body of right-minded people all over the West as well as the East.

The National Forest Service is only twelve years old; its work is far and away the greatest achievement of its kind in history. And while the States may be said to be "puttering," this is true only when compared to the gigantic task itself.

In 1903 a Michigan legislature and the State authorities could not even be induced to listen to forestry. Last winter the commission in

[1] Prepared for the Pittsburgh meeting, December 31, 1917, and January 1, 1918.

charge received its appropriations without dissenting votes, and it received $130,000 simply for reforestation, in spite of the fact that it was made clear that this was merely the beginning of a sixty-year investment program.

The State of New York may not cut timber, and it may lose a fair sum of money in decay of ripe timber, but it is organizing, it is protecting, and, taken all in all, it has made money, even by holding its forests intact.

Private owners are not yet practicing forestry, it is true; but could they practice forestry without men? Could they get the men if they wanted them? How many men with a fair training and only five years of experience (certainly a minimum) and with evidence of any real stuff are today idle, looking for work?

And let us not forget the American way (and it is the modern way, generally) is not for the buyer to look up the goods. It is the business of the young forester to seek and find and make his position and to earn his spurs. And would we want it differently? Apparently there is quite a bit of the Old World paternalistic spirit of educating only as many men as we can *assure* soft swivel-chair jobs for. It has done harm in Europe; Bavaria has broken with the habit; why, then, should we want to graft the graft on our profession? The private owners of forests in every State in the Union are ready and anxious for competent, educated help. And with cases like the D. & H. Railway before us as actual facts and accomplishments, why the faint heart?

Casting about, there is one point particularly clear in the present situation. The progress in public opinion, the change of heart in the legislatures, in the boards of directors; the willingness of timber owners to have their protective organizations, even their extension departments, headed by educated foresters is not due merely to reading of bulletins and hearing of good lectures. It is due to plain business. As long as we cut 3 billion feet of pine, it was useless to talk forestry in Michigan; but when over 80 millions in capital left the State, when whole towns were ruined, stretches of railway abandoned, and when the lumbermen told each other and the people that by 1920 three-fourths of the outfits would be done cutting, when the State authorities were finally convinced that there were 12 million acres of idle lands, mostly unfit for farming, then, and not until then, could we have the ear of the men in power.

As far as the Society is concerned, all this means chiefly four things:

Forestry in the United States has made unheard-of progress, never dreamed of, never hoped for.

Forestry in the United States is making more progress right today than ever before.

This progress calls for men and lots of them, and the best are none too good.

This progress, this development of one of the great basic industries, this organization and care of billions and billions of property, means concerted as well as intelligent action.

And here is where this Society enters as organization and leader.

The forester who, for reasons of indifference, conceit, penury, or grouch, thinks he can sit back in his little patch of wild woods and "do well enough," "make his own growth study," or what-not, will soon find out that his barnacle habits do not lead far, and that in most cases they lead off the road into the swamp and mire. The man who becomes an active member of the Society; calls on his fellow-member for conference, advice, criticism, information, stimulus, and help, will find that this Society is a very real thing—full of life, full of possibilities and help—and not the "useless sort," as pictured by a posing adviser in forestry last January at Washington, nor the "Baked-apple Club," as designated by a man who owes his fine career very largely to the Society, or at least to some of the most active members and founders of the Society.

The Society, in keeping with the history of forestry in our country, is young; it is just finding itself; it has just decided what it is, what manner of men are wanted in its membership, what lines of work are possible and practicable and useful. It has just found that an aristocratic membership based on "great achievement" does not always "pan out"; that it is useless to expect prominent engineers, artists, etc., to become and to remain members and pay their dues for service which is of no use and value to them.

The recent resignations of just such men (excellent men in themselves) proves these facts.

The Society today realizes clearly that a society of free men, and especially of foresters, must justify itself by real service to these men and their profession. No aristocratic, idealistic, large dues, and lots of fine stationary affair suffices. It must be a society that will give to any earnest, intelligent forester actual service, dollar for dollar and in full measure.

This our Society today does and does well. The greatest step in this direction was the amalgamation of the Proceedings and Quarterly into the FORESTRY JOURNAL. This journal in its first year has proved its worth. Under the excellent direction of its editors, it has demonstrated that we can have a forestry journal equal to any in quality and volume. The FORESTRY JOURNAL is worth not merely the price paid; it is a journal without which no forester can expect to keep in touch with forestry matters in this country. And surely of all countries in the world and of all times ever, our country and our times call for men who read and keep posted.

If any man will read the JOURNAL, and in addition will make use of his membership in calling on his fellow-forester, he will have no trouble in seeing what the Society is good for.

But the Society and the JOURNAL are yours; it is your interest, your action; your willingness to help the Society in moral and mental support and in paying your dues; your help to the JOURNAL in contributions and criticisms; your help to every forester who calls for it, which must make the Society the excellent means of binding together the foresters of our country.

This has been a year of stress and strain. Many of the most active members are in military service, many of them abroad. As a result, little in way of suggestions and recommendations has come up.

The permanent secretaryship is still a pious wish and calls for more money, which in turn reminds us that the dues ought to be five dollars in place of four; the JOURNAL four dollars instead of three.

Recent controversy has brought out the fact that a committee ought to look into the matter of honorary membership and submit report to the Society, with recommendations.

In closing, permit me to remind all foresters and their friends that the American Forestry Association is gathering a fund to help the foresters in the war; to help make them more comfortable and to relieve them of some of their worries regarding the people left at home. Let us all stand by our boys.

FORESTRY AND THE WAR

By Dr. B. E. Fernow

The relations of the war to forests and forestry are many; they can be discussed from a variety of points of view. There is the rôle which forests are playing in military evolutions—the consumption of materials for war uses, the destruction of forests in the war zone, the disturbance of regulated forest management where such existed, etc.

It is not my purpose to exhaust the theme, but to direct attention particularly to what I consider the most important and possibly most lasting effect, namely, upon the development of future forest policies in our country. I shall only briefly touch on other relationships.

The war has taught us, in the first place, new appreciation of the value of forests and forest products. We have been made aware of the fact that, as in olden times, forests play a not unimportant rôle in modern military tactics—important enough to pay particular attention to the maintenance of boundary forests as a matter of State policy. Indeed, the aëroplane development as a most efficient reconnoitering means imparts a particular, additional value to forest cover as a screen against observers.

Next, we have found that in modern warfare forest products are needed in large quantities, and that home supplies are preferable to importations, not only because of the possible inability of securing such, but on account of transportation difficulties.

The average trench requires alone about one cubic foot of wood to 10 feet of trench—say, 60,000 feet, board measure, to the mile, or 15 billion to the French front, not to account for shelters, artillery screens, block-houses, etc., and fuel. Such structures consume on the French front as much as $500 to $1,200 worth of wood apiece.

Again, forest industries which were on the decline or entirely abandoned have been revived by the war and new uses for wood products developed.

In Germany, cut off from the outside world, the long-abandoned naval-stores industry, based largely on spruce, and the tan-bark industry, based on oak coppice, have been revived, while in France the need of pine timber has made serious inroads in the turpentine woods of the Landes.

Wooden ships and aëroplanes call for special materials. The substitution of wood cellulose for cotton in the manufacture of explosives and the use of sawdust for cattle feed are among the new uses.

Moreover, we have learned to appreciate that certain classes of forest products are rare and of special value. Sitka spruce, once a despised material, is now found almost indispensable for aëroplane construction, furnishing long, clear, light, yet strong, material. The limited supply of such material suggests the propriety of Government control.

One of the first thoughts which the theme suggests leads us to the battlefields in Flanders, where a wholesale destruction of forest cover has desolated the country. While the territory occupied by the enemy represents only a small fraction of the whole of France, it includes a proportionally large part of the French forest area; perhaps one-fifth to one-fourth of the total forest area—the most extensive and richest portion of French forests—is located in the war zone and much of it destroyed—a sad loss, which it will take many years to repair. It is mostly privately owned, but private endeavor by the impoverished owners will prove entirely inadequate to undertake the work of restoration. There is little doubt that State aid will be needed.

Not only outside the war zone in France, but in Great Britain, the woodsman's ax has been busy cutting available supplies for war purposes. That in this cutting Canadian and American lumberjacks have been largely employed may be assumed to have made for efficiency in operation, but it may also have been secured at the expense of all silvicultural considerations. Many a forest managed under a natural regeneration system will have been cut without regard to the needs of reproduction, and French foresters will for many years to come find difficulties in returning to a sustained-yield management, which has been deranged by premature harvests.

The magnificent fir forests of the Vosges and Jura Mountains, the show pieces of French foresters, managed in selection forest, are being dismantled without regard to reproduction and with the maximum of damage to young growth.

In Great Britain the utilization of home-grown timber on a large scale will have waked up the people to the possibilities of increasing its production, and we may confidently expect a more serious effort on the part of the Government to inaugurate a forest policy which will encourage private endeavor to replace the cut plantations and for the Government to attempt the ambitious pre-war schemes of wholesale afforestation of waste lands.

The British Empire Resources Development Committee bids fair to outlast the war and become a part of the Reconstruction Committee, which has begun its work.

While in our country these more or less direct war influences are not felt to a great degree, yet there is one development which has no direct bearing on forests and forestry, but promises to be of the highest importance in the development of forest policies; it is the development of socialistic tendencies.

We are learning rapidly that government is a tool which can be made efficient, and we are learning to realize community interests as superior to individual interests. The extension of government functions has grown marvelously in all belligerent countries, so that Bellamy's description of the communistic state is not any more so Utopian as it was when first published, forty years ago.

The States that have gone perhaps farthest in nationalizing industries are the Australians.

In New South Wales not only are railroads and coal mines operated by Government, but woolen mills, cement, and even harness, factories

West Australia adds brickyards and quarries, sawmills and steamships, hotels and laundries, agricultural implements, and now even retail bakeries, butcher shops, and fish markets. The Ontario Government has undertaken at least the last enterprise, namely, to furnish fish at reasonable prices.

Under the influence of the Farmers' Nonpartisan League, the North Dakota legislature has gone so far as to declare for the principle that the State may enter upon any manufacturing or industrial field, and has taken up first State ownership of flour mills and grain elevators.

These socialistic developments have not altogether been merely dictated by war needs, but are bona fide changes of attitude toward private enterprise. We may, to be sure, not claim so much for the many Government activities which the belligerent countries, including the United States, have developed as war measures.

Congress itself has become more and more an exponent of Government ownership and control, with a tendency to State socialism. As Mr. Mann declares: "We are undergoing the greatest revolution in government which this country has ever seen."

After the war, to be sure, a formidable reaction may set in and we may experience a return to unregulated industry and to the wasteful competitive system, at least in part. But while this reaction may take place in directions of temporary character, there are other directions in which Government control will have shown itself so superior as to suggest its continuation. May we not expect that if these activities are successfully carried on there will be arguments developed for carrying on at least *some* of them beyond the war?

The control of public utilities has been under discussion long before the war, and now we shall gain experience as to how efficiently the Government can manage enterprises such as railroads, shipping, munition work, mines, not to mention the food control and control of profits.

Before the war it would have been by most statesmen considered Utopian to undertake to regulate, as we do now, production, distribution, and even consumption. Now, we attempt all these things, cutting out competition as a factor in regulating prices and substituting a cooperative system. Are we bound to return to the wasteful system of competition? Or shall we have learned that, at least as far as the natural resources that are exhaustible are concerned, communal management is the only rational method.

There is no doubt that the war and its incidental requirements have forced us into abandoning at least temporarily long-cherished theories of individual *versus* communal functions; and the opportunity for making the change permanent, for making radical changes in industrial and economic conditions after the war, will never be better, provided the opportunity is seized immediately and the pendulum is not allowed to swing back too far.

For many of the Government activities which the war has developed convincing arguments can be brought forward in favor of abandoning them to more or less unrestricted private enterprise after the exigencies of the war which called them into existence have ceased; but we may assume that the general attitude favorable to an extension of Government functions will remain and the *public* interest will more than heretofore be considered in the new adjustments.

Can we not make use of this attitude in furthering the public interests in our own special business—the conservative use and management of our forest resources? Is it not timely to point out that, if anywhere, in the handling of these resources communal interest is paramount and calls for Government control?

The arguments for such State control are familiar to you. They may be summed up in one sentence, namely, that forestry—the management of forests for continued production—is not an attractive business for private enterprise for various reasons.

At any rate, the idea of using our forest resources so as to produce continuous wood crops has so far gained little acceptance in America—none at all among the holders of the bulk of our remaining standing timber. Indeed, we may agree with Coolidge's statement, that "individual ownership has proved eminently uneconomical, and even destructive of the permanent productivity" of their lands. He does not, however, draw the proper conclusion when declaring that "there is no economic necessity for State production of timber."

Nor do we agree with Professor Toumey, who also pins his hope on private ownership, although admitting that "it is far more important to the *nation* that the second growth be adequately safeguarded than it is to the individual."

He proposes "by liberal tax laws and technical assistance to help the private owner to attain a protected reproduction, etc."

We, on the other hand, do not believe that there can be enough incentive created by these means for private forestry.

In vain have we striven for decades to interest the lumberman and timberland owner in a more conservative treatment of his property with a view to a future, to substituting silvicultural management for exploitation. Outside of protection against destruction of their property from fire, we have practically secured no response, and that naturally, for such management is financially not attractive.

Private interest in any industry can only be a financial one, but financially forestry—a sustained-yield management—means curtailing present revenue or making present expenditures for the sake of a future revenue, and that in a distant future which is of no interest to the individual.

This time element, which is peculiar to our business, is a natural deterrent to private enterprise in this field, for self-interest works only for the present. Only a long-lived, stable, permanent ownership can assure us of conservative managament; only State ownership can afford to exercise providential functions, can guard the interest of a distant future and wait a century for returns on its outlays.

That in some localities the forest cover, in addition to the mere material function, exercises a protective function on waterflow, soil, and climate, affecting local as well as distant interests—this protective function only adds argument for State control.

I repeat, we have tried persuasive and promotive methods to induce private enterprise to engage in forestry, but the inherent troubles which surround this business have rendered the result negligible. We might apply methods of control and supervision over the use of private property which might insure continuity of supplies. Experience in the old countries has shown that, in spite of much more perfect machinery for enforcing laws, and in spite of much more ready disposition to submit to laws, the attempts to control private management have been largely without the desired result.

We may come as well now as ever to the realization that forestry is and must become State business. In the main the community must own and manage the forest resources, and this in spite of the fact that at present four-fifths of the forest area is in private hands.

Such public ownerships may rest either in the Federal Government, the individual States, or other political subdivision, with the preference always for the larger unit. In the end the financial aspect of such an ambitious program of bringing the bulk of the forests of the United States back into Government ownership points to a co-operation of Federal and State governments.

In this respect, too, the war has produced new attitudes favorable to such co-operation.

The lumber industry, as is well known, is at present in economic difficulties, the causes of which have been carefully analyzed and found to be largely financial. Overinvestment in timber is one of the causes, and that condition is favorable for developing a financial arrangement with the Government taking over the properties on the most favorable terms.

In some cases where large holdings are concerned co-operation of the State with private owners is also thinkable under conditions which make for continuous production. In this connection I recall a most painstaking discussion of the situation of the lumber industry by Professor Kirkland (J. F., XV, 1917, p. 15). He works out a plan of organization in detail which contemplates a co-operative arrangement between private timberland owners by which their financial difficulties might be solved.

But we are skeptical as to the practicability of shaping the financial arrangements for private owners so as to safeguard the future regarding forest production. The future belongs to the community at large, and it or its representative, the Government, alone can be expected to make the outlay which is needed for assuring such a future.

It is, however, thinkable that a co-operation between Government and private owners might be established which would take care of the financial situation as well as the communal interests, providing a gradual change to State ownership. In the end a co-operative system, in which town or county, State and Federal Government, and private ownership take part, could be elaborated.

I suggested last year that the Society appoint a legislative committee to work out the details of such a scheme of Federal and State co-operation on practical lines, and I close with repeating this suggestion.

THE TECHNICAL FORESTER IN NATIONAL FOREST ADMINISTRATION[1]

By L. F. Kneipp

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In a recent talk before the Intermountain Section of the Society of American Foresters, Mr. Graves emphasized the fact that practically every activity connected with the management of a National Forest really is technical in character—that is, that its performance involves a number of technical processes. Arguing along this line, it may be assumed that every man engaged in the work of managing a National Forest is a technical forester. However, the purpose of this paper is not to discuss the future of the whole Forest Service personnel, but rather that part of it which is comprised of men who have devoted several years to the close study of, and systematic training in, the more technical and refined features of true forest management, and by doing so have not only earned degrees, but have met the exacting requirements of the civil-service examination for the position of forest assistant—the class of men, in other words, who very largely comprise the membership of the Society of American Foresters.

The Forest Service was created and took over the complicated administration of ninety million acres of National Forest land on February 1, 1905. At that time the technically trained forester and the field officer without technical training shared the common belief that administration under the Forest Service would involve the exclusive employment of men of technical training, which naturally would result in the complete elimination from the superior grades of the Forest Service of men who lacked such training. This was rather an exaggerated or an erroneous conception of the scope and nature of the organization which Mr. Pinchot and Mr. Price had in mind, but nevertheless it was almost general throughout the organization during the period immediately preceding and immediately following its official creation. Its origin lay probably in the more or less general recognition of the facts stated by Mr. Graves, namely, that the management of a forest is largely a matter of technical processes, which naturally

[1] Paper read before Intermountain Section, Society of American Foresters, April 18, 1917.

led to the somewhat hasty conclusion that only men who were trained in the application of such processes would have any future value in the Forest Service.

Since that date twelve years have elapsed. So far as the percentage of men of technical training within the organization is concerned, we find ourselves today in much the same situation as we were twelve years ago. The proportion of technically trained men is not much greater today than it was then; if anything, it is perhaps slightly less, because of the large number of non-technical men which since have been added to the organization. The tendency to favor either class of men in the future upbuilding of the organization is not very marked either way, but, if anything, it is somewhat toward a diminution rather than an increase in the number of technical foresters employed purely as technicians.

A man who has given any thought to the subject, regardless of whether he is or is not technically trained in the profession of forestry, must naturally speculate to some extent on the reasons why the men of technical training have not been more generally successful and have not shown more marked advancement in the Forest Service organization. Obviously they have certain decided advantages over the man without training, due to the systematic mental training which a college course usually gives, a thorough study of features of the work, and more or less familiarity, theoretically at least, with the best processes devised or formulated by the best trained minds throughout the entire world. In studying the problem many contributing factors necessarily present themselves, not all of which are ratable or subject to logical analysis; but, looking at the question from the point of view of a non-technical man with seventeen years' experience in National Forest administration, the main explanation of the problem seems to me to be as follows:

The average National Forest has always impressed me as somewhat of a battlefield, in which business, economic, and, to some extent, social conditions are in continual conflict. Throughout the West the development of all three has been sporadic and illogical rather than continuous and natural. The vast natural resources of each forest area have been prizes for which different communities and different individuals have been striving and struggling ever since the settlement of the West was first initiated. Naturally community and individual selfishness and greed are manifest to a marked degree and must be taken into consideration in every step taken in the management of the areas by the Forest Service.

If this is true, the management of human affairs is the principal problem met with in the management of a forest. A thorough and accurate judgment of men and motives is essential to a good administrative or executive forest officer, and without that he is working under a handicap which is almost insurmountable. To attain a true knowledge of the bona fides of a particular set of representations, he must understand thoroughly every cause or fact leading up to the existing condition; he must be able to appraise, and if necessary discount, the truth and accuracy of every statement made, and he must be able to analyze the sincerity or insincerity of the motives which prompt the different men with whom he deals to make certain representations or request certain actions. He must necessarily be broad in his views and must be able to keep in his mind the whole big problem of human welfare and public service as it is affected by his administrative actions, and must fit into his general scheme of administration the multitudinous and complicated affairs of thousands of individuals of the various communities.

Passing from the broad field of human affairs to the details of National Forest administration, it becomes obvious that forest management is only one of a number of activities—in fact, not always the most important one. The use of the forage resources of the forest is vitally necessary to the proper development and progress of numerous communities and much more numerous individuals; so the grazing problem is a very complicated and a very urgent one. Our somewhat archaic system of land laws creates in itself innumerable problems of forest administration, the solution of which presents complications requiring the most expert information and understanding. Consequently lands activities often are paramount over strictly forest-management activities. The vast practically virgin areas of forest land must be developed by the construction of physical improvements such as roads, trails, bridges, telephone lines, administrative sites, fences, etc., before they can be properly administered. This work requires of the officer in charge marked familiarity with at least simple methods of construction, considerable ability in the selection and purchase of the material which will best serve the purposes in mind, and still more ability in the selection and the management of men whose labor is required for the construction of the necessary improvements. Watershed protection, involving the prevention of erosion and the pollution of sources of water supply, requires good judgment and is becoming increasingly important. These are some of the material things which, in addition to silvicultural management, must be accomplished. There is in addition a wider and a still more important field, which is that of leadership—leadership of thought and action in all the communities whose interests are touched by the National Forests. The real executive must have the faculty for impressing people with his sincerity, his integrity, and, above all, his real ability in the performance of the work to which he is assigned. He must be able to imbue the people with whom he comes in contact with a sympathetic and comprehensive understanding of the aims and purposes of the Forest Service, the methods by which he purposes to accomplish such aims and purposes, and the reasons for the procedure which is being followed and which touches the lives or interests of all residents of the near-by communities. A forest officer who can do this is bound to succeed, and one who cannot is almost certainly doomed to failure.

Idealism has its proper place in National Forest administration, but its importance should not be unduly magnified. The administration of a forest is a business undertaking, and, as in any other business undertaking, success is gauged and demonstrated by the preponderance of benefit over effort. Everything done must have a purpose; everything done must justify itself by the return of some beneficial result which clearly is in excess of the energy and money required to accomplish it. There should, of course, be proper thought given to the future, but the needs of the future should be finely balanced against the needs of the present, so that neither need will be unnecessarily sacrificed for the other. There should be no thought that time will adjust or cover over mistakes of the present.

These, then, are some of the aspects of National Forest administration which must present themselves to every man aspiring to an administrative or executive position. How well equipped is the average technically trained forester to meet these requirements within the ten-year period following the granting of his degree? In the great majority of instances he comes from a wholly different environment, where different ideals, different codes of conduct and morals, different traditions, different points of view, have prevailed for generations and combine to create an atmosphere wholly dissimilar to that in which the man will be compelled to work. The men with whom he has been brought in contact during his earlier career were of a wholly different type and character from the men with whom he will be thrown in contact in the practice of his profession. He comes out fully conversant with the theory of scientific forestry and finds that it conflicts with the practice of forest utilization which has grown up throughout the region to which he is assigned, or, worse still, he finds that there is no opportunity for the practice of forestry, because the entire demand for timber is confined to a few picayunish sales at cost, or the sawmill operations total an annual utilization of perhaps two thousand trees.

The situation necessitates a complete mental readjustment on the part of the man, a subordination of many of his ethical and social views, a putting aside of a great deal of the theory mastered by long years of careful study, a complete readjustment, in other words, both mental and physical. It is necessary for the man to assimilate different standards, ideals, and modes of thought before he can put himself in a proper relationship toward the men with whom he is thrown in contact. It is necessary for him to absorb a great deal of information with regard to human selfishness, deception, and unreliability before he can divest himself of the gullibility which makes him a mark for the unscrupulous individuals whose affairs he sometimes has to handle. He must acquire an entirely new perspective, to some extent, and entirely new ideals of public service; he must learn to compromise and be content with a partial success as against a possible total defeat.

When a man has done this he has passed simply the preliminary stage of his more mature development. His technical training has touched but lightly upon the problems of grazing management, but in his official work that problem stands out as of paramount importance. He therefore must master all of its details, which include, first, a knowledge of the physical limitations governing the handling of stock upon open ranges and the methods of management which, by reason of physical limitations, have necessarily been evolved; second, the big features of range management, which have been worked out by the members of his own organization, such as the deferred and rotation system of grazing, the open herding and bedding out methods, and, third, the rather detailed procedure for apportioning grazing privileges between contending applicants. These three aspects of the common problem constitute in themselves a wide field for specialized work, and yet they are only one of several important phases of National Forest administration under present-day conditions.

A man's technical course will probably touch but lightly upon the general system of land laws which governs the distribution of the public lands in the Western States. The laws, numerous as they are, really constitute only a basis for a multitude of decisions having all the force and effect of laws, a knowledge of which is more or less necessary for thoroughly accurate action upon a specific case. The lands work is another wide field for specialized action, but, notwithstanding this, is simply one feature of forest administration.

Fire protection probably enters somewhat into the average forestry course, but in an elementary way. The forest officer is confronted with a condition rather than a theory and must formulate a plan of protection which will adequately meet the condition. This involves the careful co-ordination of a number of elements, and on the average forest offers in itself a field upon which a man could very properly specialize for a considerable period of time; yet fire protection is simply one feature of forest administration.

Permanent improvements require the display of considerable knowledge regarding construction methods, specifications, materials, sources of supply, skilled and unskilled labor, and organization. This is work which probably is not touched upon in the average technical course, and yet it presents a wide field of semi-technical requirements, which must be mastered before the executive is in a position to act with thorough intelligence.

The organization itself, which may be classified as the work grouped under the branch or office of Operation, presents almost innumerable problems. First and foremost is the selection of men, the assignment of men, and the relationship between the executive and his subordinates. Obviously he must have qualities of leadership or he cannot lead; he must have superior ability in many ways or he cannot make good his official superiority. He must have a knowledge of what constitutes good work, both in quality and volume, so that there will be no unreasonable demands and no soldiering. He must, to some degree at least, have a sympathetic understanding of the points of view, temperament, and general psychological condition of the men under him, so that he may deal with them tactfully and considerately, but not weakly.

Having mastered this feature of his work, the executive finds himself in a maze of departmental and service regulations, civil-service regulations, fiscal regulations, allotment estimates and records, and more or less frenzied finance in the proper application of the moneys allotted to his Forest. Much of this is routine; some of it vitally affects the standards of the man's work and the performance of his functions as a part of the big machine. This in itself would offer a field for specialization, and yet a considerable degree of familiarity with every detail must be possessed by the man who aspires to be a successful executive.

The technical man who makes himself the master of these major lines of work, supplemented by numerous unnamed activities of minor character, has an assured future in the higher ranks of the Forest Service and may aspire to any position in the organization up to and including that of the Forester. The man who cannot master these various details, many of which are foreign to the practice of scientific forestry, must necessarily content himself with a comparatively subordinate position or with highly specialized technical work. Roughly, the Service activities divide into two classes—one, the administrative work, which to a greater or less extent necessitates a more or less complete mastery of all the activities enumerated herein; and the other, specialized work in some feature of true forest management. The man of technical training who is now in the Service probably will always be able to find some niche which he can satisfactorily fill, but he will not be able to realize his highest ambitions unless he squares with the specifications laid down herein.

Comment may be made here upon one manifest weakness of the average professional forester. One would logically assume that the practice of forestry would be in the woods where the timber grows, or in mills where the timber is manufactured into raw materials, or in the shops where it is manufactured into finished products. In the first two instances the practice of the profession must necessarily be under rather primitive and not wholly comfortable conditions. It manifestly is impossible for every trained forester to be a swivel-chair forester, with headquarters in a main town and an itinerary including all of the best hotels in the region. To the contrary, a great many men must find their field in the woods, with headquarters at logging camps, or in the mills with headquarters in the small towns. These are the places where the forester of the future is going to win his recognition and establish the reputation of his profession. Too much of the practice of the profession has been detached from trees and sawmills and has been concentrated on blue prints, typewritten reports, and printed bulletins.

The above fact is impressing itself with increasing strength upon the officials of the Forest Service and is becoming an acute problem in the handling of the technically trained men. The places where their services are needed are of the kinds above described; the places where they wish to work are the places where modern comforts and conveniences are readily obtained. This latter inclination probably is due to the fact that many of the men are married to women of culture and refinement, who throughout their entire lives have been accustomed to all of the comforts and conveniences of modern life, and therefore cannot very well adapt themselves to existence at mountain logging camps or in primitive sawmill towns; neither can they adapt themselves to frequent changes of assignment involving the giving up of social and other ties and the establishment of new ties in some other place, which, unfortunately, may be broken before they are firmly established. The technical man of the day should give serious consideration to this condition and should endeavor to decide whether he wishes to practice his profession under the most favorable conditions possible, which would involve considerable sacrifice of domestic comfort and social enjoyment, or whether he prefers these obviously very material features of modern life to an extent warranting a partial sacrifice at least of his opportunities to practice his profession under conditions which offer the highest opportunities for material accomplishment.

COMMENTS ON KNEIPP'S PAPER, "THE TECHNICAL FORESTER IN NATIONAL FOREST ADMINISTRATION"

[The subject touched upon by Kneipp is of the most vital importance to the Forest Service and to the profession. The Editors hope that its discussion, therefore, will not end with Toumey's and Spring's comments, but will be followed by contributions from many others. We want particularly to hear from the non-technical and technical men themselves now in active forest work.—Ed.]

By J. W. Toumey—

If Kneipp wished to write an article to show the superiority of the non-technical forester over the technical one, it seems to me he should have gathered statistics. He states that the relative proportion of technical men to non-technical has decreased during the past ten years rather than increased. Would it not be an easy matter to follow out the record of technical men and compare it with the record of non-technical men?

We all know that when first employed an experienced axman or sheep herder, even without brains, is likely to be more useful than a man without woods training, no matter how much technical instruction he has had. Even in districts which in the past have been inimical to technical men, I have found the contempt has, to a large measure, ceased and the persons in command have come to realize that their past attitude was a mistake. The districts which have for years held technically trained men in more regard than eleswhere in the Service, in my judgment, can point to the quality of the work as superior to that elsewhere in the Service. Kneipp is at the head of a district in which timber forests are relatively insignificant and where grazing dominates. Probably in his district, more than anywhere else in the Service, the need of men with technical training in the care and management of woods is less urgent; but even in this district, if the administration fails to grasp the point of view, fails to see the importance of organizing the district primarily to protect, improve, and extend the little forest that they now have, it seems to me they have no purpose of existence within a forest service, in the truest sense. What if grazing does dominate the district economically? This should not act as a fog to hide the real purposes for which the forest reserves in District 4 were created, namely, to protect and improve the forests.

In my judgment, Mr. Pinchot, Mr. Graves, and Mr. Price had the correct point of view when the forests were organized, namely, that the organization and management of the forests should be based upon technical knowledge.

I question Mr. Kneipp's inference that technically trained men have been less successful than non-technical men. Mr. Kneipp states that the average National Forest impresses him as a battlefield, in which the business, economic, and, to some extent, social conditions are in continual conflict. I do not believe these are more in conflict on the National Forests than elsewhere. The development of a National Forest might be likened to the development of a large farm. Do you suppose the agricultural colleges and agricultural research stations we have developed in every State in the Union would have attained the position that they now occupy in national economy if the work which they are doing did not really make American farms more productive? Thorough technical training in agriculture is known these days to be essential for the greatest success.

The management of a National Forest looks forward for many years. It is not concerned primarily with the petty differences which arise from day to day between business and social conditions. It is more intimately concerned with the direction that the development of the forest takes. The right direction of development needs and must have technical training and experience. Would Mr. Kneipp urge the gradual reduction of technically trained men and the increase in employment of non-technical men until the entire personnel of the National Forest was made up of untrained men from the purely technical point of view?

We all appreciate the fact at the present time that a vast number of activities on the National Forest do not require forestry training. Although this is true, the man in charge of the forest or in charge of a given part of the work on the forest must be able to look ahead to something that approaches the ideal and toward which his work must move if he has the correct notion of the work.

Kneipp mentions the importance of leadership. I also recognize this importance. Where is leadership to be found? Among uneducated or non-technical men or among educated, technically trained men? To be sure, one will occasionally find a natural leader without technical training, but the chances of leadership there are going to be much less than among the technically trained men, and, in my opinion, the experience in the Forest Service for the last ten years proves it.

I agree with Kneipp that the administration of a forest is a business undertaking, but today are not the General Electric Company and other large business undertakings looking to the colleges and selecting technically trained men for leadership in their enterprises rather than men who have grown up in the business, starting in as water-carrier?

I believe the National Forests should be managed by men having a good administrative and executive capacity, but I believe also that that capacity can be found more frequently in the technically trained men.

This matter, it seems to me, is hardly worth controversy. If, however, it is worth while, I would like to see a study made of the total personnel of the Forest Service from its organization down to the present time, showing the effectiveness of the work of non-technical men as compared with those with technical training.

I fully appreciate the fact that a man with a technical training must, from the nature of things, serve his apprenticeship on the forest, where he is later going to work, before he can be a very effective man. The Forest Service should appreciate this, however, and if they expect to have able men as leaders, they must show, in my judgment, more encouragement to technically trained men that are brought into the Service.

In European countries the man with technical training serves an apprenticeship before he secures an office of responsibility. When he has served the apprenticeship, however, he stands out clearly and definitely superior to men without a technical training. It ought to be this way in the United States.

By S. N. Spring—

Perhaps the most striking thing in this paper is the author's utter misconception of the term "forest management." It may be defined as "The application of forestry in the business of the forest."[1] Forest management deals with *all* the business of the forest. Of its branches, "Forest Organization"[2] (or regulation) orders the work of silviculture, both in respect to time and place; plans an orderly harvest of the stands of timber; plans the necessary improvements, divisions of the forest, necessary roads, and other means of protection and utilization of the forest. Forest administration carries out the plans, but is not sharply separated from organization. Forest valuation concerns itself with income and outlay, the value of the forest investment, and is a necessity in every line of forest work.

In general, forest management purposes to make the best use of *all* resources of the forest.

[1] Forest Terminology, JOURNAL OF FORESTRY, Volume XV, No. 1.
[2] See Forest Regulation, pp. 1-2, Roth, Ann Arbor, 1914.

Of necessity it deals with the various phases discussed in this paper.

(1) Human activities, the social and economic side.

(2) National Forest administration, in which the author of the paper includes much that is a part of forest regulation as indicated above. Perusal of any standard outline of a forest working plan reveals the inclusiveness of forest management. That one or another phase of work, as indicated in the article, occupies the most prominent place on a given forest is of no special significance in reference to the need or the place of technically trained foresters.

The premise, therefore, that forest management occupies in many cases a subordinate position is without foundation. Possibly the writer had in mind silvicultural operations only.

Mr. Kneipp challenges the equipment of the average technically trained forester for the work of forest management on National Forests. Compare this with any other profession, if you please. Is a young, technically trained engineer just out of college conversant with the economic and social aspect of the new field into which he goes? Is he a master of men and a trained administrator or manager of large business interests? Any man entering the practice of his profession must adapt himself to environing conditions, must develop those powers necessary for carrying large responsibilities, or remain in a subordinate position.

The practice of forestry—that is, the management of the forest for continuous production of timber and other products and the maintenance of forest influences—may not be fully realized on all National Forests at the present. Its future depends on those men who, with an adequate training in theory and practice, have the vision and the ability to bring about that practice. Its realization cannot be secured by non-technical men whose minds deal only with the handling of public property as a business, considered outside or aside from forest management in its fullest sense.

The "one manifest weakness of the professional forester" is only the weakness of mankind, after all—a doctrine easily promulgated by any one who may sit in high places in the centers of civilization.

In forestry or any other similar profession there may be those who find no liking for isolation or for restrictions not found in previous environment. Men in almost every profession change into other occupations for one reason or another. This may arise from wrong choice at the outset, or that the man is not adapted or fails to adapt himself to his work, uncongenial personal relationships or surroundings, failure of superior officers to utilize the man to advantage, or the actual undesirability or restricted character of the positions available. It does not rest on or reflect upon the man's technical training nor is it an argument against technical training of men for forest management.

Because the financial advantages of Federal positions in forestry are small, advancement slow, surrounding conditions often those involving real hardship, and the most worthy position of all, that of forest manager or supervisor, so restricted by forms, reports, instructions, etc., as to prevent originality, it is a wonder that so many technical men have remained in the Service and made good.

Another possible cause for the so-called weakness of the technical man may be the inability of executive officers to train the young forester in the business of the forest, such as is done in any other profession. He has largely to train himself in those matters of local nature with which he is thrown into contact.

RELATION OF STIMULI TO THE CONE PRODUCTION OF WESTERN HEMLOCK

By Russell Watson

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A fact well known to botanists is that plants which have enjoyed a period of thrifty growth may often be made to reproduce if factors of growth are introduced which suddenly check the rapid vegetative activity. Such factors which inhibit the growth of the plant may be thought of as stimuli to reproductive activity. It should not be understood from this that because a plant is growing slowly that it is necessarily reproducing actively; runty corn-stalks bear runty ears, and a neglected orchard bears little as well as poor fruit.

Many examples may be cited which indicate the relation between abundance of food and vegetative and reproductive activity. Many fungi which will not produce spores when grown on a medium abundant in food, when grown on a medium poor in food value will often bear fruiting bodies. Under certain conditions annuals may be transformed into biennials or perennials by keeping them under conditions favorable to vegetative activity, and in the same manner plants which normally flower every year may be kept from flowering for several years. Hydrophitic plants when grown under xerophytic conditions may flower annually, although if grown under their native environment may flower only rarely. Such instances are common knowledge to the botanist.[1]

The occurrence of the seed crops of the forest trees has long been a matter of decided interest to foresters, principally, perhaps, because of its importance in the practice and determination of silvicultural methods. A description of the silvicultural characteristics of a tree usually includes, as a matter of course, a statement of the periodicity of heavy crops of seed. Indicating this, the following statements are typical: "Some seed is borne every year, but heavy seed years are of irregular occurrence." "A prolific seeder, exceptionally heavy crops every three to five years," etc.

Yet Zon writes: "When several years ago an attempt was made by

[1] For further discussion see "Text-book of Plant Physiology," Pierce; Pfeffer's "Physiology of Plants"; MacDougall's "Text-book of Plant Physiology," etc.

the Forest Service to collect seed . . . it was keenly realized for the first time how little knowledge exists in this country regarding the seed production of our trees and the factors which influence it." "Our knowledge of the life history of forest trees will be incomplete until the mysterious occurrence of seed years and the factors which influence them are fully understood." "Little as yet is known regarding the factors which influence the seed production of even the few European species," . . . although these species have been studied for a great many years.[2]

In 1914, during a rather extensive investigation of the reproduction of western hemlock while at the University of Washington, the relationship between heavy seed crops on individual trees and distinct external causes was quite accidentally hit upon. Once found, however, and with the relationship confirmed by the contributory evidence which the botanist offered, the line was eagerly followed during the school term.

Very little is found in our American literature concerning the relation of stimuli to the seed production of trees. G. A. Pearson, of the U. S. Forest Service, has conducted some preliminary investigations along this line. His published conclusions, however, deal "primarily with the conditions (of the tree) affecting the germinative quality of the seed"; the "influence upon the quantity of seed, though of great importance," is "treated only as a secondary topic," because the data were incomplete.[3] Such of his conclusions as are considered pertinent and of value are included further on in this article.

The investigation as conducted on western hemlock was simply one of observation. Due to lack of time, no verifying experiments were completed, but the data as gathered appear to warrant some preliminary statements.

In most forest investigations correct deductions are more easily obtained from affirmative data than from negative data. Of a hundred trees in the forest, possibly but two or three bear heavy crops. To determine why the ninety-eight trees are not bearing heavily is of less importance in the solving of this problem, and, of course, much more costly and difficult, than to determine why the two or three are bearing heavily. With this consideration in mind, the method of attack of the problem was to locate western hemlock trees which were bearing exceptionally heavy crops of cones.

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[2] "Seed Production of Western White Pine." Raphael Zon, Chief of Forest Investigations. Bull. 210, U. S. Dept. of Agriculture, 1915.

[3] "The Age and Condition of the Tree upon the Seed Production of Western Yellow Pine." U. S. Forest Service, Circular 196, 1912.

Trees bearing heavily were located by diligently tramping the roads and trails of a great part of the Puget Sound country. In all, it is probable that fifty days were spent in this manner. Some time was also spent examining hemlock trees which had been felled in logging operations. If a tree were found which was bearing heavily, unless too large, it was given a thorough examination. Generally the tree was climbed. The trunk and limbs were examined carefully for injuries; twigs were examined to determine past seed years,[4] and in some cases even the roots of the trees were examined. Thus small trees were examined literally from top to bottom. Points particularly noted were: The site, the rate of growth, the treatment to which the environment had been subjected (through logging, fire, etc.), the amount of seed produced, evidences of past seed years, injuries to the tree (such as fire, insects, fungi, mechanical bruises, etc.), and the general health and position of the tree in the crown cover. About 300 trees were examined in greater or less detail. Most of these trees either bore heavy crops of cones on the tree as a whole or on some individual limb in particular. Other trees were examined for a number of reasons, generally as checks and for comparison. Most of the trees examined either had been attacked by insects or fungi, scorched by fire, suffered from mechanical injuries, such as decapitation, trunk and limb abrasions, partial windfall, or had been left after logging and had been subjected to the lowering of site conditions due to drying out of the soil and loss of humus.

It is of interest to note that on a study of this kind it is practically impossible to tabulate the data obtained in order that one unfamiliar with the work might judge of the correctness of the conclusions reached. The reason for this may be as follows: An attempt is made to establish a fact. In this case it is whether or not hemlock trees are stimulated to seed production by external factors. Even though the fact be well established as a generality, yet the response of the tree to various stimuli may vary greatly in intensity under different circumstances. These circumstances particularly are the intensity of the stimulating factor and the size, age, and health of the tree prior to becoming affected. A very large, healthy, tree affected with a maximum stimulation will respond very differently than one which was in poor health prior to stimulation. There are, moreover, a half dozen

[4] This was done by the location of the cone scar in reference to the annual growths. It was found possible to determine whether or not a twig had borne any cones during the past six years. Determinations were much more difficult on young twigs than on old, slowly growing sprays.

obvious stimulants, any one of which may act either singly, independently, or in combination with any other. In fact, the stimuli usually do act in combination. Any one of these stimuli or combination of them may act with greatly varying effect upon trees which differ greatly in health, growth, etc. It is impossible to combine these variables and give the result as a definite figure, for the reason that no one can state accurately the value of the separate factors, even when in a simple combination. When these factors are combined into complex combinations, then to evaluate them separately is practically impossible.

The result of all this is that a *tendency* only can be given: this tendency must be accepted as the fact which was to be proved.

If this matter of a check upon the accuracy of the work be considered a dilemma, then probably the other horn to it would be to give the complete set of notes taken on the study. This, however, is not practicable for lack of space.

With these considerations in mind, the following conclusions are believed to indicate the results of the investigation:

Periodicity of Crops.—Considering the Puget Sound region only, no definite year could be decided upon as having been an especially good seed year. Individual trees were commonly found which bore seed in large amounts for two or three years in succession. Indeed, some hemlocks bore heavy crops for at least five successive years. On the contrary, healthy, rapidly grown trees, as well as old decadent trees, were found which had borne little or no seed for at least five years. In fact, some trees, although healthy and growing rapidly and over fifty years old, had not borne heavy crops of cones for fully fifteen years (from evidences on twigs and cones on ground), if indeed they had ever borne a heavy crop.

But it should not be understood from this that there are not occasionally exceptionally good seed years for hemlock in the Puget Sound region. It is well understood that exceptionally heavy crops of seed of pines appear more or less regularly. If, however, heavy crops do come at more or less regular intervals, then it would appear that the causes for the heavy crop must recur thus regularly. The following from MacDougall indicates this: "So long as conditions favorable to vegetative growth are prevalent, reproductive processes are not carried on so freely as when adverse intensities of various trophic forces prevail." This is "richly illustrated by the activities of the higher plants" (loc. cit., p. 325). This present season (1917) offers an exceedingly heavy crop of cones of spruces, cedars, hemlocks, as well as with many of the hardwoods and white pine (to some extent) over a great part of the Lake States pinery region.

The studies indicate, however, that for western hemlock no regular periodicity of cone crops could be determined. If there is some inherent rhythm in the production of heavy crops of seed of this tree it was not discovered. It is very doubtful that there is such.

Age of Seed-bearing.—It was definitely shown by the study that the age at which hemlocks first begin to bear seed is entirely subject to the conditions governing the growth of the tree. It was found that although one hemlock may bear a heavy crop when twenty years old or less, another tree alongside of it may bear none, or but very few, until much later in life. This is due to stimuli which affected the heavily bearing tree alone. It is believed that some hemlocks bear no heavy crops until at least a hundred years old, even though growing under healthy conditions. In this regard it is interesting to note that small saplings were found which although but ten or fifteen years old bore seed copiously.

Quantity of Seed Produced.—The important point in this connection perhaps is the fact that trees of all sizes, from small saplings to large, full-crowned trees, at times were found simply covered with cones. One 25-year-old tree, which had been growing about a foot a year in height until fatally injured by bark borers, by actual count bore 1,445 cones in one year. Cone counts were made of several large trees which had grown vigorously in the open by counting the cones on a number of branches and then applying the result to all the limbs of the tree. The trees obviously were fruiting heavily, but the actual results were astounding. It was found that such trees at times bore 15,000 cones in a single year. Many trees observed had borne from 5,000 to 10,000 cones a year for several years. The cones of western hemlock are small, seldom being over an inch long, but each cone contains about forty seeds. These trees, therefore, produced over 500,000 seeds in one year.

Naturally the larger the tree the more sprays it has and the more cones it can bear. In this respect it is self-evident that a mature tree can bear more cones than an immature tree. The trees which bore the heaviest had been injured after having enjoyed a long period of rapid growth. The amount of seed produced by thrifty, uninjured hemlocks in general is most decidedly less than those which were bearing as a result of stimulation through injury.

In this connection Zon's conclusions from his study of the seed production of western white pine (loc. cit.) are of interest: Conclusion five states: "The vigor of growth apparently influences favorably the amount and quality of seed produced. Thus trees which grew at the rate of 0.19 inch diameter and about 1.25 feet in height annually produced a larger amount of germinable seed than trees which grew at a slower rate. This, however, may be indirectly the effect of the age of the tree, since the younger trees have not yet passed the period of most rapid growth." In conclusion number three he points out that young trees from 72 to 100 years old bear more germinable seed than old trees, and in conclusion two that "the largest amount of germinable seed was invariably produced by trees" of the dominant and codominant classes.

G. A. Pearson, in his work on the seed production of western yellow pine (loc. cit.), states that "a comparison of yellow pine and black jack[5] shows an average yield of 1.8 bushels of cones per tree for the former and one bushel for the latter." He attributes this difference mainly to a difference in size of the tree. He also says: "The yield of trees suffering from suppression and attacks of bark beetles and mistletoe are all much below the normal trees of their class." And further: "The yield decreases as the density of the stand increases."

Location of Cones.—It was found that a single limb on a tree may bear an exceedingly heavy crop of cones, although the remainder of the tree be practically barren of cones. In such cases it could not be found that there was any special relation between the location of the limb on the tree and the direction of greatest light or warmth.

This irregularity of seed production indicates and suggests that the heavy production of cones by individual hemlocks is due in great measure to causes or stimuli, of which the following are the most obvious, if not the most important. Hemlocks, of course, bear cones without the aid of these stimuli:

Fire.—A tree which is so scorched that is is wounded quite severely almost invariably responds with a heavy cone crop. Hemlock has such a thin bark and its roots are so close to the surface of the ground that a light ground fire is sufficient to stimulate the tree.

Insects.—The action of bark-boring insects is a decided stimulus to cone production. (The action of defoliation insects was not observed.) If the infestation be not so serious as to fatally wound the tree and yet be continuous, the tree will be likely to bear heavy crops for several years in succession.

This is especially the case if the tree is growing rapidly on a good site.

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[5] Black-jack trees are western yellow pine trees of a younger generation than are the more mature (western) yellow pines.

Fungi.—Although a number of trees were examined which were badly rotted, nothing definite could be determined as to the effect of the rot upon the seed production of the tree.

The action of *Razymoufskya* .sp., which causes a witches-broom growth on the limbs of hemlock, is toward a vegetative stimulation. Unfortunately the cases of witches-broom observed were such that it could not be decided whether or not this stimulation tended to inhibit the production of cones.

Mechanical Injuries.—Healthy trees which had had their tops taken off in logging or snapped off by wind, or by other causes, were very interesting. It was found that very often those limbs which were *immediately* under the break produced very heavy crops for a year or two after the accident. The trees examined, however, which had responded to this stimuli bore seed not more than two years in succession after the accident, and generally only one year. There is probably a relation here between the response to the stimuli, the duration of the response, and the rapidity with which a new leader is formed. Trees partially girdled often bore heavy crops.

An injury to the trunk immediately below a limb was often the cause of the limb bearing heavily. The rubbing of one limb on another was found to cause a seed production on the limbs outside the rub. Such a condition was especially noticeable when, as was often found, no other limb on the tree was bearing cones in abundance. This point was considered of great importance in deciding that external factors exercise a deciding influence upon the cone production of trees.

Trees partially wind-thrown, with some broken roots, but yet with a sufficient number left to carry on life in the trees, often produce heavy crops. These crops may continue for several years in succession.

Light.—Nothing definite could be found as to the effect of light as a stimulus to seed production.

Soil and Moisture.—Nothing definite could be determined.

Date of Injury.—On this point, unfortunately, data could not be gathered. Very likely it is one of the most important factors in the relation between injury and cone production. It is a matter for experiment.

One conversant with the facts, as are the investigators,[6] can scarcely doubt that hemlocks are stimulated to cone production by fires, insects, etc., and many conjectures based upon this fact might be made regarding the ease of stimulation of hemlock (that is, thickness of bark) and its tolerance and position in the forest.

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[6] J. H. Billingslea collaborated with the author during a considerable part of this study.

The cause and the effect of stimulation are apparent, but the reason why the cause produces the effect is probably not well known by plant physiologists. Hartig assumes that an accumulation of food acts as a stimulus to seed production. This hypothesis has not been proven to be wrong. But this theory does not deny that other stimuli may also cause seed production.

SUMMARY

Very little is as yet known regarding the factors which influence the seed production of trees. Botanists have shown that the vegetative and reproductive activity of plants may be controlled to a certain extent by controlling the factors which influence the growth of the plant.

If the vegetative activities of thrifty western hemlock trees are suddenly checked by injuries, the tree usually is stimulated to reproductive activity. Factors which commonly stimulate the tree thus are injuries by fire and insects, mechanical abrasions, wind-throwing, decapitation, and girdling.

VALUATION OF DAMAGES TO IMMATURE TIMBER

By W. N. Sparhawk

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In the not far-distant future our extensive stands of virgin timber will be gone, and outside of parks and inaccessible mountain districts there will be no such thing as a large stock of overripe trees. Forest owners will then be concerned with the business of forest production rather than with that of utilizing a stored-up product. While possibly a large share of this business will be carried on by government agencies, either local or national, there will in all likelihood still remain a very large area of true forest land in private ownership. To attract private individuals or corporations, the business of producing timber must be at least as safe as other legitimate operations requiring long-term investment of capital. Not only must the investor be assured that he will not lose his capital, but this capital investment must have negotiable value in case he should wish at any time to dispose of the business, and he must be able to borrow money at reasonable rates on the security of his business as in other forms of investment. In other words, young stands must have as definite value and be considered as good security (or better) as the merchantable stands upon which in a number of instances money is now borrowed by means of timber bonds.

To bring about such a condition, not only must the values of young timber be generally recognized and efficient systems of protection against fire and other destructive agencies be organized, but there must be insurance against loss which may occur in spite of such organization. Few careful investors would put their money into an ordinary manufacturing business if there were no fire-protective system for the plant or if the factory could not be insured. To develop fire insurance on a sound scientific basis requires statistics of losses over a long period. With laws and public sentiment in many parts of the country now lined up for forest protection, the only really serious obstacle to organizing a system of forest insurance against fire, at least, is the lack of accurate statistics of fire losses. One of the weakest points in statistics of forest-fire damage in the United States is the valuation of damage to stands below merchantable size. In the great majority of cases such damage has been either left entirely out of consideration or estimated in a most arbitrary manner, so that it is practically impossible to determine the relation between total forest values involved and amount of loss. The appraisal of values of immature stands has presented considerable difficulty, due in part to the uncertainty as to quantity and value of product, date of receipt of income and costs of production, and even more to the introduction of compound interest computations and the somewhat confusing combination of capital investment and accumulated product which is involved in the business.

With the progress of investigative work, it should be even easier to predict time and quantity of yield from a forest than is the case with a fruit-grower who attempts to judge in advance what his new orchard will produce. It should also be as safe to figure with present values[1] for timber and costs of production as it is for the orchard owner to use present fruit prices and costs in his computations. While prices may increase, any figures based on such increase are pure speculation and have very little place in conservative financial calculations. It does appear reasonable, however, to use the best present stumpage prices in estimating yields of young stands, since present inequalities due to differences in transportation facilities will probably be evened out in the future.[2] The mathematical principles of valuation have been considerably clouded by the confusion of capital and accrued earnings and by mixing the ideas of interest and profit or loss—that is, the commercial interest rate and the rate actually earned by the forest.

To confusion of ideas as to what constitutes the investment and what is merely accumulated earnings on this investment may be attributed much of the discussion of values of forest stock and much of the controversy between "soil-renters" and "forest-renters" which has filled so large a place in foreign forestry literature. The methods of valuation which have been proposed may be classed under five general heads:

1. Arbitrary proportions.
2. Cost of production or replacement.
3. Expectation value.
4. Sale value.
5. Value of accumulated rentals.

The first method, which is at the same time the simplest and the least scientific or accurate, disregards the compound-interest element entirely.

[1] Present values mean here the average for a short period to avoid any abnormality which might control prices at the moment.

[2] See Kraft: Zur Praxis der Waldwertrechnung und forstlichen Statik, 1882, p. 21.

The simplest arbitrary method has been used by some National Forest Supervisors in valuing young stands for statistical or other purposes; the value of young timber is set either at an arbitrary figure per acre or at an arbitrary per cent of the value of old timber in the vicinity, practically regardless of age of stand, although this may be considered in a vague way in setting the value. Another arbitrary method, proposed by District 2 of the Forest Service, for statistical purposes is to capitalize at an arbitrary per cent the mean annual yield, which is obtained by dividing the yield (apparently gross yield) at maturity by age of maturity. The formula may be expressed $V = \frac{Y}{n \times .0p}$, where V is present value, Y yield at maturity (n years) expressed in money, and .Op the arbitrary rate of capitalization. This method disregards age of the stand entirely. Besides the objections that it uses simple instead of compound interest and omits consideration of costs of production, it does not give the value of the stand at all, but the capital value of soil stocked with potential forest.

G. L. Hartig used essentially this formula to get soil value, in his instructions for valuation of Prussian forests in 1814. On account of the poor mathematical training of foresters of that day and on account of the negative results often encountered with compound interest formulæ, he avoided the use of compound interest and found the mean annual yield by dividing total yield at maturity, including intermediate yields without interest, by the age of rotation. He deducted an arbitrary fraction of this gross yield, depending on age of the stand, as a sort of insurance and to cover costs and interest charges, and multiplied the remainder by the actual age of the stand.[3] This value for the stand may be expressed by the formula:

$$V_m = \left(\frac{Y + T}{n} - \frac{Y + T}{n \times k}\right) m,$$

in which V_m is value at the given age (m), Y value of final yield, T value of intermediate yields, n age of rotation, and k an arbitrary constant.

Frey[4] recommends Hartig's method, apparently without the deduction for costs.

Albert[5] and Roth[6] suggest this method as a rough way of getting at

[3] Borggreve: Die Forstabschätzung. Berlin, 1888, pp 359-360.

[4] Zur Lösung der Waldwertrechnungsfrage, in Zeitschrift für Forst und Jagdwesen, May, 1915, p. 284; abstract in Forest Quarterly, March, 1916.

[5] Lehrbuch der Waldwertberechnung, Wien, 1892, pp. 20ff.

[6] Forest Valuation, 1916, p. 101.

the value, while they admit its inaccuracy. It is hardly necessary to argue the scientific inaccuracy of this formula, which may be expressed:

$$V_m = \frac{Y \times m}{n}$$

but it will perhaps suffice to note that, leaving out costs, and even if we can assume that $\frac{1}{n}$ of the yield is produced each year, to pay an owner $\frac{Y}{n}$ each year if his stand should be burned that often would make his indemnities at the end of the last year amount to $\frac{Y(1.0p^n - 1)}{n \times .0p}$, or vastly more than he would have received had his original stand grown to maturity. With a stand worth $100 at 100 years and interest at 3 per cent, he would receive from his timber $100, or in case it burned every year for 100 years after it was a year old, $607.29.

The cost of production method has been very generally recommended, particularly for very young stands and for artificial plantations. The formula is given variously as (simplest forms, disregarding intermediate returns already received, and using English symbols):

$$C(1.0p^m) + (S + E)(1.0p^m - 1)$$

in which S may apparently be either cost or expectation value of soil[7] (expectation value with normal forests):

$C(1.0p^m) + (S_c + E)(1.0p^m - 1)$, where S_c is cost of soil;[8]
$C(1.0p^m) + E(1.0p^m - 1)$ for plantations and
$E(1.0p^m - 1)$ for natural stands.[9]

It is admitted by most of the writers who favor this method, as well as by others, that cost is really no measure of value. Thus Martin, who

[7] Faustman in Allg. Forst-und Jagdz., 1854, p. 84, quoted by G. Heyer in Anleitung zur Waldwertrechnung, 4th ed., Leipzig, 1892, p. 93, and
Schlich: Manual, Vol. iii, 1911 ed., pp. 127ff.

[8] Roth, Forest Valuation, 1916, p. 62, and
Chapman: Forest Valuation, 1915, p. 126.

[9] Standard Instructions for the Determination of Fire Damage, U. S. Forest Service Mimeo. Cir., May, 1916, and
Chapman: Forest Valuation, pp. 126-127.
See also
Borggreve: Die Forstabschätzung, pp. 380ff.
Keiper: Waldbrandversicherung, in Forstwissenschaftliches Zentralblatt, 1910, reviewed by Gaertner in Allg. F. und J. z., 1910, pp. 224ff.
Martin: Allg. F. und J. z., Dec., 1910, pp. 421ff.
Stoetzer: Waldwertrechnung und forstliche Statik, 4th ed., Frankfort-a-M., 1908, p. 116.
Abstracts in Forest Quarterly, March, 1915, of articles in Allg. F. und J. z., May, 1914, and in Schweizerische Zeitschr. für Forstwesen, Nov., 1914.
Albert: Lehrbuch der Waldwertrechnung, pp. 20ff.

says cost is theoretically correct, admits that it does not measure the value of old stands, but that sale value governs.

Nisbet[10] says: "The cost of production has nothing to do with the prospective returns, because these depend mainly on factors (local market, soil and situation, suitability of crop, distance of plants, treatment as to thinnings, etc.), not necessarily in any manner determined by the amount of money spent in forming the plantations."

Liefmann[11] says: "The method of cost value is pure fiction—has no real economic basis."

Chapman[12] says: "Cost is an individual outlay; value is the product of social conditions." "The objections to the use of cost of replacement as a measure of damages are that it does not represent the true value of the property nor measure the loss." "Wherever there is a marked divergence in the two, whether cost exceeds or is less than the value, the collection of damages based on cost cannot be justified by any principle of law. Its use is clearly a makeshift." "The higher the interest rate the greater the cost and the smaller the value of the crop."

Borggreve:[13] "The costs actually expended may be expended very uneconomically. The proof of the economy of this expenditure would always have to be shown, which brings us back to the expectation value."

Riebel:[14] "The new owner does not care what it has cost to produce the stand, what soil rent and administration cost has been charged against it, what revenues the previous owner has already derived from it."

Jaquot[15] objects that the cost method "omits all recognition of skill, vigilance on the part of the owner, results of good management, well-executed markings, judicious selections of periods of exploitation; . . . draws no distinction between neglected forests and those properly managed, between intensive and reckless exploitation."

Wimmenauer[16] points out that while cost might determine the value of a perfect product—bricks or cigars, for instance—it cannot determine values of imperfect products. "In the forest almost every stand is subject to one irregularity or another; . . . it would often come about that one would value the poorer stand higher than the better."

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[10] The Forester, Vol. 2, 1905, p. 390.

[11] Die Entstehung des Preises aus subjectiven Wertschätzungen, in Archiv für Sozialwissenschaft und Social politik, Vol. 34, No. 2, Tübingen, quoted by Glaser in Centralblatt für d. g. Forstwesen, Jan., 1913.

[12] Forest Valuation, pp. 44, 126, 127, 131.

[13] Die Forstabschätzung, p. 379.

[14] Centralblatt für d. g. Forstwesen, Jan., 1915; abstracted in Forestry Quarterly, March, 1916.

[15] Incendies en Forêt; trans. by C. E. C. Fischer, Calcutta, 1910, p. 25.

[16] Allgemeine Forst-und Jagdzeitung, Dec., 1910, p. 424.

The truth of this last statement is clearly shown if one considers, for instance, two 25-year-old stands of Douglas fir—one in Colorado, where growth is slow, yields low, cost of successful planting fairly high, and the other in western Oregon, where growth is rapid, rotations fairly short, yields large, cost of planting low. By the cost method the Colorado stand would appear to be worth at least as much and usually more than the Oregon stand, which would be contrary to fact. Roth[17] says that timber values in the United States will eventually be determined by the cost of growing timber, as is now the case to a certain extent in parts of Europe. While this might be true if the business were entirely in private hands and if forests were grown for no other purpose than the production of timber, it seems open to question as long as the Federal Government and States adhere to the policy of maintaining a forest cover on the headwaters of important streams partly for timber production, but even more for the public benefits involved in watershed protection and other influences of forests. Douglas fir prices may be determined by what it costs to produce it in the Northwest, but Douglas fir will continue to be grown and sold in the Rocky Mountain region, even though the cost considerably exceeds the returns.

Several writers,[18] to overcome the objection that two similar stands are of equal value, though their cost has actually been different, advocate using cost of replacement at present prices rather than the actual cost. This is open to the same objection as the use of actual cost and is even less satisfactory, because it not only does not represent the value of the stand, but does not even represent what the owner has actually paid out. Since the principle underlying all estimates of damage should be to restore the owner to the same financial position he was in before the damage was done,[19] he should not receive either more or less than he would have received had his forest not been injured. If it is not injured, he will receive whatever the crop will bring in the market, less future costs up to maturity, or if young stands had a market value, he would receive this market price, which would be equal to cost of production *plus any profit he may have made* by good management or favorable conditions, *or minus any loss he may have incurred* through poor management. Damages awarded to him should therefore include this profit or loss, as well as actual cost; if he has spent too much on his stand and lost money, he is not entitled to get back his loss by burn-

[17] Forest Valuation, p. 42.
[18] Albert: Lehrbuch der Waldwertberechnung, pp. 20ff.
Stoetzer: Waldwertrechnung und forstliche Statik, p. 118.
[19] See Standard Instructions for the Determination of Fire Damages.

ing up the stand, while if he has managed well and the forest has accumulated a profit, he is certainly entitled to recover such profit in addition to what the stand has cost. The use of soil expectation value instead of soil cost or sale value in the formula for cost of production does allow for this profit or loss. The value thus obtained, however, is the value of the stand as a product, without considering its value as part of the producing capital. Soil expectation value means not the value for the most advantageous use after removal of the present stand, as stated by Stoetzer,[20] but the value for the present actual use.

Expectation value has been most generally favored as the correct basis for valuing young stands, although many writers, as noted above, have favored cost value for very young stands and for artificially established stands. The expectation value of a stand means simply the present value of its net return at maturity, less the present values of the cost of production from the given year to the year of maturity. It is expressed in its simplest form (disregarding intermediate returns):[21]

$$\frac{Y - (S + E)\ (1.0p^{n-m} - 1)}{1.0p^{n-m}}$$

in which S is apparently sale or cost value, or expectation value in case of normal stands;

$$\frac{Y - (S_c + E)\ (1.0p^{n-m} - 1)}{1.0p^{n-m}}$$

which uses cost value of soil;[22]

$$\frac{Y + S_v + E}{1.0p^{n-m}} - (S_v + E) = \frac{Y - (S_v + E)\ (1.0p^{n-m} - 1)}{1.0p^{n-m}}$$

in which S_v is expectation value of the soil;[23]

$$\frac{Y - S\ (1.0p^{n-m} - 1)}{1.0p^{n-m}}$$ is proposed by Riecke,[24] König,[25] and Wirt.[26]

The use of soil cost and .0p interest rate has the same defect as actual cost value—that is, it overlooks the element of profit or loss already accrued. If both expectation and cost formulæ as given by Roth are correct,

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[20] Waldwertrechnung und forstliche Statik, p. 124.
[21] Heyer: Anleitung zur Waldwertrechnung-Leipzig, 1892, p. 82.
Schlich: Manual, Vol. III, 1911.
[22] Roth: Forest Valuation, p. 64.
[23] Chapman: Forest Valuation, p. 98.
[24] Über die Berechnung des Geldwerthes der Waldungen, 1829, p. 15.
[25] Forst mathematik-3d ed., 1846, Sec. 492-493.
[26] Report Penna. Dept. Forestry, 1901-2.

$$\frac{Y-(Sc+E)(1.Op^{n-m}-1)}{1.Op^{n-m}}=C(1.Op^{m})+(Sc+E)(1.Op^{m}-1)$$

or reducing, $Y=C\ (1.Op^{n})+(Sc+E)\ (1.Op^{n}-1)$.

In other words, the final yield is worth just what it cost to produce it, and there is neither profit nor loss. This means that .Op is the rate actually earned by the forest, or .Ox, not an arbitrary rate chosen beforehand. If an arbitrary rate .Op is used, it will be necessary to use the expectation value of soil rather than cost value. Without using S_e the expectation value formula can give negative values for stands, which is absurd. The capital value of soil for forest production may well be negative, meaning that at present prices the cost of production exceeds returns from the product; but to say that a product which has a positive sale value at maturity can be worth less than nothing some time before maturity does not sound reasonable. The objection to use of expectation value of very young stands on the ground that it gives very low values[27] has no weight as long as such values are positive, as they will be if based on S_e. The product value of such stands, which expectation value represents, really is very small, and their value as part of the forest capital, which is the most important part of their value, is not included in the expectation value. The cost value formula, using Sc, can also give negative results for stands from which intermediate returns have been received. Especially is this true of stands, such as those on the National Forests, where cost of land and planting was zero and administration cost has been very low.

Most writers agree in recommending the use of sale value for stands of merchantable size, even though not necessarily at the age of rotation.[28] Glaser[29] attempts to get around the use of either cost or expectation value, even for young stands, by using actual sale value as soon as the stand has a sale value greater than its cost (not considering interest), and for younger stands a value determined by the formula $(Y_x-C)\frac{a^2}{x^2}+C$, where Y_x is sale value at x years, when first merchantable without a loss; a is the actual age of the stand and C the cost of the stand. Actual sale value is the correct one for stands which have reached maturity, assuming that the rotation is fixed at the age of

[27] See Standard Instructions for the Determination of Fire Damages, 1916, p. 7.

[28] See Standard Instructions for the Determination of Fire Damages, 1916; Forstwissenschaftliche Zentralblatt, Aug., 1910, article by Keiper, reviewed by Gaertner in Allg. F. & J. z., 1910, pp. 224ff.; Chapman, Forest Valuation, p. 128.

[29] Zur Praxis der Waldwertsberechnung-Centralblatt für das gesamte Forstwesen, January, 1913.

maximum returns. It is not correct for stands younger than the age of rotation, even though the timber has a sale value, since if not damaged the owner would receive a greater sum at maturity, which would include not only his profits or loss up to the year of injury, but also such profit or loss for the additional period up to maturity. If the rotation has been fixed correctly, the rate of interest earned by the forest at that age will be greater than that earned at an earlier age. It has also been suggested that to be really correct the valuation of mature stands which cannot or will not be cut for a number of years should be based on a discounted sale value rather than an actual present sale value.[30] This could perhaps be done if the date of cutting could be even approximately foretold; but as long as such dates are almost entirely dependent on chance, and until definite working plans have been prepared, such a valuation would have little value. It may also be considered that with rising prices, particularly for the upper grades of lumber, the values of such mature stands will probably increase fast enough to compensate for the delay in their utilization.

Cost and expectation value formulæ, if S_e is used, give the same result, which is the value of accumulated earnings on the capital invested, and can be expressed in a somewhat simpler formula, which does not require the computation of S_e or E.

Albert[31] worked this formula out for naturally reproduced stands. He says the cost of production at any age, m, is the accumulated interest on the soil expectation value, together with the sum of expenses and interest. If $S_e = \frac{Y}{1.0p^n - 1} - E$, then cost $= S_e\ (1.0p^m - 1) + E\ (1.0p^m - 1) = \frac{Y\ (1.0p^m - 1)}{1.0p^n - 1}$. The expectation value of the stand is $\frac{Y - (S_e + E)\ (1.0p^{n-m} - 1)}{1.0p^{n-m}} = \frac{Y - \frac{Y\ (1.0p^{n-m} - 1)}{1.0p^n - 1}}{1.0p^{n-m}} = \frac{Y\ (1.0p^m - 1)}{1.0p^n - 1}$.

Riebel[32] gets the same formula in a different way. He says that the annual rental which amounts to Y in n years is $\frac{Y \times .0p}{1.0p^n - 1}$, and that

[30] Roth: Forest Valuation, p. 91.
Chapman: Forest Valuation, p. 132.

[31] Lehrbuch der Waldwerthberechnung, Wien, 1862, p. 35.

[32] Centralblatt für das gesamte Forstwesen, Jan.-Feb., 1915, pp. 1-15; abstracted in Forestry Quarterly, March, 1916.

the sum of m years rental is $\frac{Y \times .Op \times (1.Op^m - 1)}{.Op \times (1.Op^n - 1)}$, or $\frac{Y\ (1.Op^m - 1)}{(1.Op^n - 1)}$. He seems to neglect cost, too.

Jacquot[33] gets a similar formula, but instead of .Op uses .Ox, the actual interest rate earned by the forest, whose value he estimates somewhat arbitrarily. This will not give the same results except at the year O and the year n.

Chapman's[34] formula for expectation value of the stand, if carried out further, gives the formula for accumulated rentals. He says the value is $\frac{Y + S_v + E}{1.Op^{n-a}} - (S_v + E)$ (a is the same as m in other formulæ), and that S_v is $\frac{Y - C}{1.Op^n - 1} - (C + E)$. If this value be substituted for S_v in the first formula, we get

$$\frac{Y + \frac{Y - C}{1.Op^n - 1} - (C + E) + E}{1.Op^{n-a}} - \left[\frac{Y - C}{1.Op^n - 1} - (C + E) + E\right]$$

or $$\frac{Y\ (1.Op^a - 1) - C\ (1.Op^a - 1.Op^n)}{1.Op^n - 1}$$

or $$\frac{(Y - C)\ (1.Op^a - 1)}{1.Op^n - 1} + C.$$

Cost value, with S_e, gives the same result. Thus cost is $C\ (1.Op^a) + (S_e + E)\ (1.Op^a - 1)$; substituting for S_e,

$$= C\ (1.Op^a) + \left[\frac{Y - C}{1.Op^n - 1} - (C + E) + E\right] (1.Op^a - 1)$$

$$= \frac{(Y - C)\ (1.Op^a - 1)}{1.Op^n - 1} + C$$

Perhaps a clearer way of deriving this formula, since it avoids the use of the expectation value of soil and shows the combination of interest and profit which makes up the value, is the following: The profit at the end of the rotation is $P = Y - (S_e + C + E)\ (1.Op^n - 1) - C$; that is, the yield, minus interest on investment, minus sum of annual expenses, minus depreciation in investment (C, where artificial reproduction is used or where seed-trees are sacrificed for reproduction).

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[33] Incendies en Forêt-Fischer's translation, pp. 70ff.
[34] Forest Valuation, pp. 133-134.

The annual profit which in n years will amount to P is $\frac{P \times .0p}{1.0p^n - 1}$ or substituting the value of P given above,

$$= \left[\frac{Y - C}{1.0p^n - 1} - (S_c + C + E)\right] \times .0p$$

The sum of m years annual profits, with interest, $= \frac{P\,(1.0p^m - 1)}{1.0p^n - 1}$

$$= \frac{(Y - C)\ (1.0p^m - 1)}{1.0p^n - 1} - (S_c + C + E)\ (1.0p^m - 1)$$

The actual cost of the stand at m years is the cost of establishment, with interest, plus interest on cost of land, plus sum of annual expenses, $= (S_c + C + E)\ (1.0p^m - 1) + C$. The sum of actual cost and profit accrued to year m is then:

$$\frac{(Y - C)\ (1.0p^m - 1)}{1.0p^n - 1} + C$$

With natural reproduction this reduces to $\frac{Y\,(1.0p^m - 1)}{1.0p^n - 1}$ and the same result is obtained with artificially established stands which will be reproduced naturally in succeeding rotations.

All of these methods give the value of the *product*, but do not cover the value of the stand as part of the producing capital. If a stand is destroyed without impairing its capital value, the loss will be equal to the value of the stand or part of stand destroyed. But it is frequently the case that the capital is also more or less damaged. This capital value is made up of two elements—the actual capital invested and the capital value of the profit or loss involved in the business. The capital invested is $S_c + C + E$. The capital value of profit or loss is annual profit divided by .0p, or $\frac{P}{1.0p^n - 1}$, which equals $\frac{Y - C}{1.0p^n - 1} -$ $(S_c + C + E)$. Since $\frac{Y - C}{1.0p^n - 1} - (C + E)$ is expectation value of soil, capital value of profit equals $S_e - S_c$, and the total capital value of the business is

$$(S_c + C + E) + (S_e - S_c) = S_e + C + E = \frac{Y - C}{1.0p^n - 1}$$

Where both stock and land are destroyed the damage will be

$$\frac{(Y - C)\ (1.0p^m - 1)}{1.0p^n - 1} + C + S_e + C$$

(since E is released for other purposes, not lost). Substituting for S_e, the total loss is $\frac{(Y - C)\ 1.0p^m}{1.0p^n - 1} + C - E$.

Since the amount of the capital originally invested, being an actual cost, is not changed by the damage, the loss falls on the capital value of the profit, or $S_e - S_c$, and equals $(S_e - S_c) - (S_e^1 - S_c)$, or $S_e - S_e^1$, the difference in expectation values of the soil before and after the damage. The total loss is

$$\frac{(Y - C)(1.0p^m - 1)}{1.0p^n - 1} + C + S_e - S_e^1; \quad S_e \text{ is } \frac{Y - C(1.0p^n)}{1.0p^n - 1} - E;$$

in case of total loss S_e^1 (all future income minus all future cost) is $\frac{Y^1}{1.0p^n - 1} - (C^1 + E^1)$, where Y^1 and E^1 are zero, and $C^1 = C$. $S_e - S_e^1$ then equals $\frac{Y - C}{1.0p^n - 1} - E$, and total loss is

$$\frac{(Y - C)\,1.0p^m}{1.0p^n - 1} + C - E, \text{ the same as above.}$$

Ordinarily, however, the destruction will not be so complete, but in addition to the loss of the stand further damage will consist of (*a*) an increased cost of establishment, particularly where intended natural reproduction must be given up for artificial reproduction, with or without additional costs for preparing the ground; (*b*) increased expenses for protection, due to the increased hazard on burned-over areas; (*c*) decreased productivity of the soil, due to actual reduction in its fertility, to erosion, or to invasion by brush or inferior species of trees, such as lodgepole pine, in regions where it is of secondary importance as a timber tree. Where the original forest calls for natural reproduction, S_e is $\frac{Y}{1.0p^n - 1} - E$. If planting is required to restore the stand, and succeeding generations can be reproduced naturally, S_e^1 will be $\frac{Y}{1.0p^n - 1} - (C^1 + E)$, so that the loss in capital will be C^1. If the original forest calls for artificial reproduction for each crop, its S_e is $\frac{Y - C(1.0p^n)}{1.0p^n - 1} - E$, and if the stand must be planted after the damage and for all succeeding crops at the same cost, S_e^1 will also be $\frac{Y - C(1.0p^n)}{1.0p^n - 1} - E$, and there will be no loss in capital. If the new stand and all future stands call for a cost different from C, S_e^1 will be $\frac{Y - C^1(1.0p^n)}{1.0p^n - 1} - E$, and the capital loss will be $\frac{(C^1 - C)\,1.0p^n}{1.0p^n - 1}$

If, as is more likely to be the case, the first cost is different, but future ones the same as C, S_e^1 will be $\frac{Y - C}{1.0p^n - 1} - (C^1 + E)$, and the capital loss $C^1 - C$.

If annual expenses for protection and other purposes are changed permanently, S_e^1 will become $\frac{Y - C\,(1.0p^n)}{1.0p^n - 1} - E^1$ and the capital loss will be $E^1 - E$. If the change lasts for one rotation only, S_e^1 will be $\frac{Y - C\,(1.0p^n)}{1.0p^n - 1} - \frac{E^1\,(1.0p^n - 1) + E}{1.0p^n}$ and the capital loss will be $\frac{E^1\,(1.0p^n - 1) + E}{1.0p^n} - E = \frac{(E^1 - E)\,(1.0p^n - 1)}{1.0p^n}$. If the new costs apply to part of one rotation only (b years), S_e^1 will be

$$\frac{Y - C\,(1.0p^n)}{1.0p^n - 1} - \left[\frac{E^1\,(1.0p^b - 1)}{1.0p^b} + \frac{E\,(1.0p^{n-b} - 1)}{1.0p^n} + \frac{E}{1.0p^n}\right]$$

$$= \frac{Y - C\,(1.0p^n)}{1.0p^n - 1} - \frac{E^1\,(1.0p^b - 1)\,(1.0p^n) + E\,(1.0p^n)}{1.0p^{b+n}}$$ and

the loss in capital value will be

$$\frac{E^1\,(1.0p^b - 1)\,(1.0p^n) + E\,(1.0p^n)}{1.0p^{b+n}} - E = \frac{(E^1 - E)\,(1.0p^b - 1)}{1.0p^b}$$

If the productivity of the soil is reduced, Y will be reduced, so that (simplest case, assuming C and E unchanged) S_e^1 will be

$$\frac{Y^1 - C\,(1.0p^n)}{1.0p^n - 1} - E.$$

The capital loss will then be $\frac{Y - Y^1}{1.0p^n - 1}$. If Y^1 is different for one rotation only, S_e^1 will be

$$\frac{Y^1 + \frac{Y}{1.0p^n - 1}}{1.0p^n} - \frac{C\,1.0p^n}{1.0p^n - 1} - E,$$ and the loss $\frac{Y - Y^1}{1.0p^n}$.

If invasion by a different species compels the adoption of a different rotation (q), S_e^1 will become $\frac{Y^1 - C\,(1.0p^q)}{1.0p^q - 1} - E$, and the capital loss will be $\frac{Y - C\,(1.0p^n)}{1.0p^n - 1} - \frac{Y^1 - C\,(1.0p^q)}{1.0p^q - 1}$. Where a regeneration period (k years) is necessary to start the new stand the effect will be to increase the length of the first rotation, and S_e^1 will be

$$\frac{\frac{Y - C\,(1.0p^n)}{1.0p^n - 1} - E.}{1.0p^k}$$

The capital loss will be $\left[\frac{Y - C(1.0p^n)}{1.0p^n - 1} - E\right] \times \left[\frac{1.0p^k - 1}{1.0p^k}\right]$.

A few examples will show how these formulæ work.

(1) Given a stand of Douglas fir, Quality 2, will produce 100 M, worth $2 per M, in 100-year rotation. Cost $6 to establish in first place, but will reproduce naturally after logging. Annual costs, $.06. Interest, 3 per cent. Burns at 60 years, natural reproduction will follow immediately, and costs remain the same.

Loss is (*a*) stand........ $\frac{200 \times 1.03^{60} - 1}{1.03^{100} - 1}$ = $53.70

(*b*) capital .... no loss.

(2) The same, but reproduction requires ten years to come in.

Loss = (*a*) stand $53.70

(*b*) capital:... $\left[\frac{(Y - C(1.0p^n)}{1.0p^n - 1} - E\right] \times \left[\frac{1.0p^k - 1}{1.0p^k}\right]$

$$= \left[\frac{200}{1.03^{100} - 1} - 2\right] \times \left[\frac{1.03^{10} - 1}{1.03^{10}}\right] = \$2.55$$

(3) Same as (1), but annual expense $.09 for 25 years, on account of extra fire hazard.

Loss = (*a*) stand $53.70

(*b*) capital.......... $\frac{(3 - 2)\ (1.03^{25} - 1)}{1.03^{25}}$ = $.52

(4) Same as (1), but must plant after fire, at cost of $10.

Loss = (*a*) stand $53.70

(*b*) capital 10.00

(5) Original stand to be replanted each rotation at cost of $6. Cost $10 first time after fire, on account of down logs, etc., and $6 in succeeding rotations.

Loss = (*a*) stand $53.70

(*b*) capital .... 10 — 6 = $4.00

(6) Same as (5), but cost after fire only $6.

Loss = (*a*) stand $53.70

(*b*) capital .... no loss.

(7) Same as (1), but soil so injured that but 75 M feet will be produced in first 100 years after the fire and 100 M in succeeding rotations.

Loss = (*a*) stand $53.70

(*b*) capital .... $\frac{200 - 150}{1.03^{100}} = \$2.60$

(8) Soil will be occupied after fire by lodgepole pine, which will produce but $50 worth of material in an 80-year rotation.

Loss = (*a*) stand $53.70

(*b*) capital........ $\frac{200}{1.03^{100} - 1} - \frac{50}{1.03^{80} - 1} = \$5.69$

(9) Stand in (1) is destroyed when 10 years old and costs $6 to replant.

Loss = (*a*) stand $3.78

(*b*) capital 6.00

(10) Stand destroyed in same year that it was established and must be replaced at $6.

Loss = (*a*) stand $0.00

(*b*) capital 6.00

The table gives values for the factor $\frac{1.0p^m - 1}{1.0p^n - 1}$ at different ages and for several rotation periods at 3 per cent. With the use of these figures and the money value of yields, taken from yield tables, the valuation of stands of any species, age, or quality should be comparatively simple. (The values given represent a Y of $1.)

Age (m)	Rotation (n)								
	40	60	80	100	120	140	160	180	200
10	.1520	.0703	.0357	.0189	.0102	.0056	.0031	.0017	.0009
20	.3564	.1648	.0836	.0442	.0239	.0131	.0072	.0040	.0022
30	.6310	.2918	.1480	.0784	.0423	.0231	.0127	.0070	.0039
40	1.0000	.4624	.2346	.1242	.0671	.0367	.0202	.0111	.0062
50	......	.6918	.3510	.1857	.1004	.0549	.0302	.0166	.0092
60	......	1.0000	.5074	.2685	.1451	.0793	.0436	.0240	.0133
70	......	......	.7175	.3797	.2052	.1121	.0616	.0340	.0188
80	......	......	1.0000	.5292	.2860	.1563	.0859	.0474	.0262
90	......	......	......	.7301	.3945	.2156	.1185	.0654	.0361
100	......	......	......	1.0000	.5404	.2953	.1623	.0895	.0495
110	......	......	......	......	.7365	.4025	.2212	.1220	.0674
120	......	......	......	......	1.0000	.5464	.3004	.1657	.0915
130	......	......	......	......	......	.7399	.4067	.2243	.1239
140	......	......	......	......	......	1.0000	.5497	.3031	.1675
150	......	......	......	......	......	......	.7418	.4091	.2260
160	......	......	......	......	......	......	1.0000	.5515	.3047
170	......	......	......	......	......	......	......	.7428	.4104
180	......	......	......	......	......	......	......	1.0000	.5525
190	......	......	......	......	......	......	......	......	.7434
200	......	......	......	......	......	......	......	......	1.0000

THE WHITE-PINE WEEVIL AND ITS RELATION TO SECOND-GROWTH WHITE PINE[1]

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The white-pine weevil, *Pissodes strobi* Peck, is one of the most serious native pests of young white pine, *Pinus strobus,* and annually deforms and otherwise injures a large percentage of the sapling pines throughout its range. Because of its conspicuous injury, this insect was early brought to the attention of entomologists and is frequently mentioned in entomological literature. Its life history, however, was never accurately described until 1907, when Hopkins[2] described it fully. Up to that time the white-pine weevil had frequently been confused with other species of the same genus which had entirely different habits.

The work of this weevil may easily be distinguished from that of any other, since it is the only species in the range of the white pine that works in the terminal shoots of the young trees, and it is found working nowhere else. In addition to white pine, the weevil attacks Norway spruce very freely and has been reported frequently as feeding on Scotch pine.

A part of the data included in this article was collected in the vicinity of Ithaca, New York, during 1915 and 1916, and a part near Grande and along the St. Croix River, in Minnesota, in the fall and spring of 1916-1917.

The Adult Weevil

The adult weevil is a small, somewhat elongated, rusty to dark brown, snout beetle, varying in length from four to five mm. The proboscis is slender and not longer than the thorax. The thorax is marked with two distinct white dots and each elytra with a white blotch on the posterior third.

Point of Attack and Types of Injury

The white-pine weevil seldom, if ever, actually kills a tree. It attacks the terminal shoot or leader and the injury is usually confined to the

[1] Published with the approval of the Director as Paper No. 83 of the Journal Series of the Minnesota Agricultural Experiment Station.

[2] Hopkins: "The White-pine Weevil." Circular No. 90. U. S. Department of Agriculture, Bureau of Entomology.

part above the topmost whorl, but cases have been frequently observed where the injury has extended below the second or even the third whorl from the top. So great an injury may result in the suppression and eventually in the death of the tree when it is growing in a close stand.

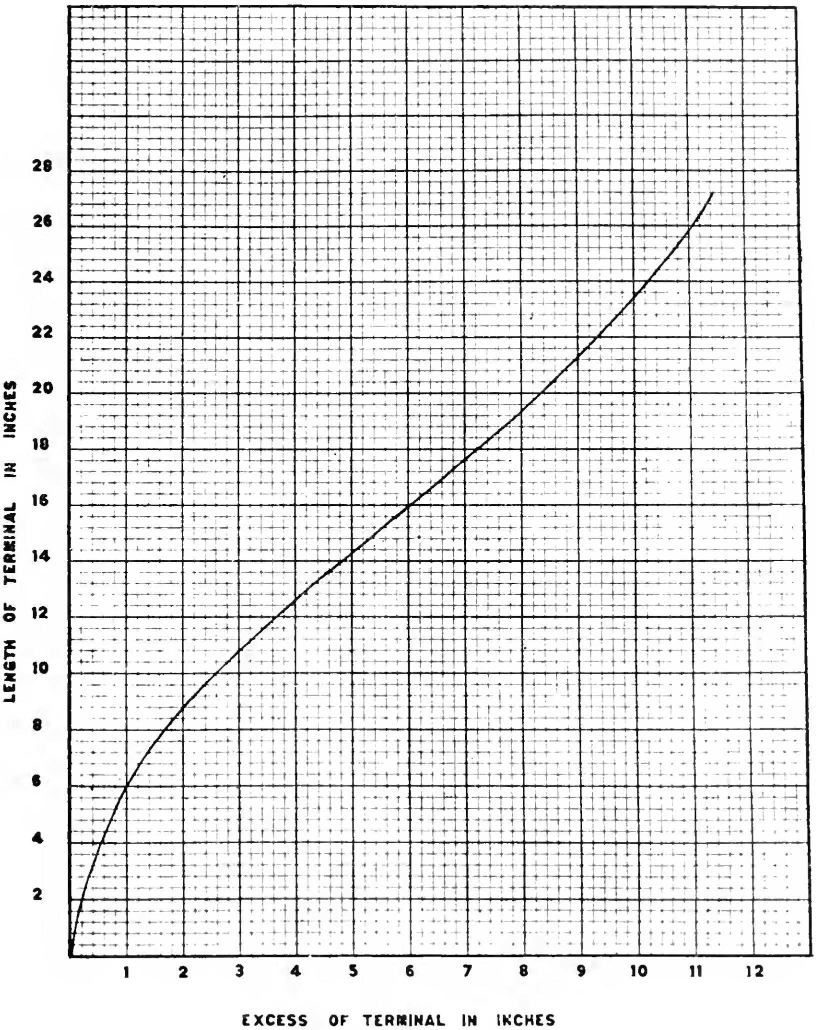

FIG. 1.—Excess of the terminal shoots over the corresponding laterals

The injury caused by the killing of the leading shoot may result in: (1) A *forked trunk*, formed by two or more lateral branches taking the place of the single leader. This may occur in dense stands.

This forked trunk may endure throughout the life of the tree and very seriously affects its commercial value.

(2) A *crooked or "bayonet" trunk*, formed by a single lateral taking the place of the leader. This condition may disappear entirely, the trunk becoming straight, and at maturity may be as valuable as though never injured. In case of repeated attacks on the same tree, which often occur, particularly in open stands, the loss in quality may be great.

In addition to this, the injuries result in a considerable loss of height growths. Since the white pine produces an excurrent stem and up to the age of about 60 years the leading or terminal shoot is a direct vertical extension of the trunk of the tree, the removal or death of this leader, then, directly reduces the height growth. This leader is almost invariably longer than the lateral branches of the same age. The curve (fig. 1) shows the average excess of the terminal shoot over the longest lateral for terminals up to 28 inches in length. This curve was constructed from measurements of 300 trees. It is evident that the greater the length of the terminal killed the greater will be the loss in height growth. Measurements of about 500 weeviled shoots show the average length of such terminals to be 16 inches in Minnesota, and in New York State 170 weeviled shoots averaged 19 inches. Referring to the curve, it will be seen that for each weeviling there is a loss of from 6 to 8 inches in height growth. This is assuming that only the terminal is killed and that the longest lateral from the topmost whorl takes the lead. If the injury extends below the topmost whorl the loss is increased accordingly. The crooks and forks resulting from weevil attacks increase to a considerable extent the possibility of winter injury by snow and ice.

Life History

There is but one generation a year in New York State. The adults appear on the pines about the time the earliest trees are beginning to leaf out and when the pine buds are just beginning to swell. They begin at once to feed upon the buds, usually those of the terminal, and in a few days oviposition begins.

The eggs are laid in chambers hollowed out of the inner bark by the female, one or two eggs being placed in a chamber. As a rule, the female remains on one leader until she has deposited her full quota of from 75 to 150 eggs; but if she is disturbed she may drop to the ground and is then likely to find her way to another tree, thus destroying two leaders. The egg-laying continues into July.

In from 6 to 10 days the eggs hatch and the young larvæ burrow downward beneath the bark, feeding upon the cambium layer. As they grow larger they consume all of the inner bark and cut furrows into the wood. As soon as a larva is full grown, it turns into the pith and there forms a pupal cell, or if the pith is already occupied by other larvæ it will make a cell beneath the bark and roof it over with shreds of wood. In about 30 days after hatching from the egg the larva transforms to the pupal stage. This lasts for nearly two weeks and then the transformation to the adult takes place. The adult remains in the pupal cell for a week or more and becomes thoroughly hardened before chewing its way through the wood to the outside.

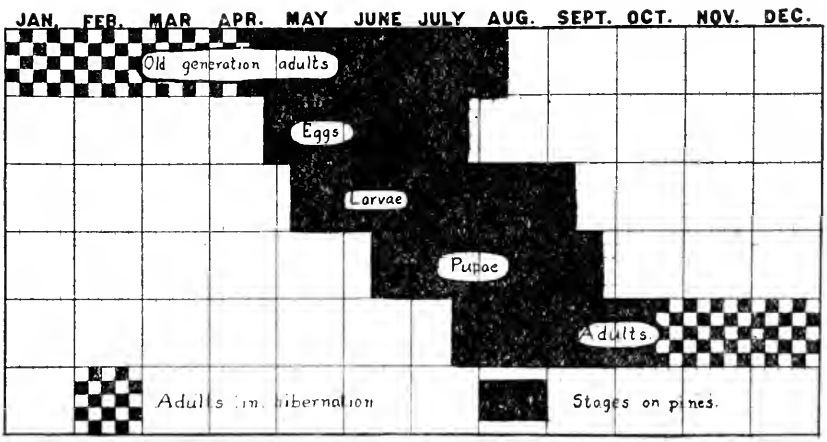

FIG. 2.—Seasonal history of the white-pine weevil, *Pissodes strobi* Peck

After feeding on the new shoots of the pine for some time, these newly emerged weevils seek out a place in the litter beneath the trees and hibernate until the following spring.

Distribution

The white-pine weevil is distributed over the entire range of the white pine, occurring in some sections much more abundantly than in others. The map shows the per cent of weeviled trees found in the most heavily infested stands of young pines in the various sections of the white-pine region.[3] It will be seen that there is a heavier infesta-

[3] For these data I am indebted to correspondents in the different sections. In Minnesota some of the figures are from personal observations and the rest were obtained through the State forest rangers.

tion in the Northeastern States than in Minnesota. The reason for this difference cannot be explained with any degree of certainty at the present time, although there are several factors that may have an influence, such as the occurrence of natural enemies of the weevil in Minnesota, which are not found in the East, the extent of spring and fall fires, and differences in the silvical habits of the white pine in West and East.

In so far as has been found up to the present time, there are no parasites of the weevil found in Minnesota that do not occur throughout its

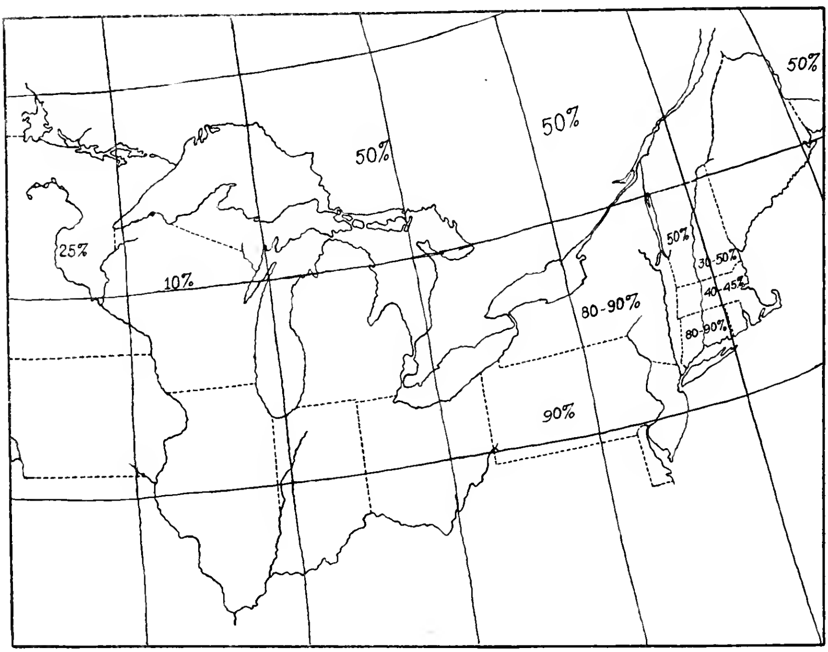

Fig. 3.—General distribution of the white-pine weevil in the range of its host tree

whole range. Certainly there are none abundant enough to cause such a difference between the two sections. Neither is there any greater abundance of birds which might help to control the weevil. It is probable, however, that there have been more extensive spring fires in Minnesota and Wisconsin than in the Eastern States and this may have had some influence. A light fire burning through the litter in the spring, before the emergence of the adult weevils from hibernation, would undoubtedly kill immense numbers of them. If such a fire were extensive, it would reduce the number of weevils materially in the area burned. The most common parasites of the weevil pass the winter in the dead terminals on the trees, and if the fire were not too hot they would be uninjured. This would result in an excessive number of parasites and nearly a complete control in the burned area would result. The superfluity of parasites in the burned area would find their way, more or less, into the surrounding country and there would be an extra heavy parasitization of weevils immediately surrounding the burn. Where light brush fires are common year after year, as they are in Minnesota, their effect on the weevil should be noticeable. Such fires are, however, even more injurious to the pines than the weevil injury, and burning for weevil control should, of course, never be resorted to.

The difference in the silvical habits of the white pine may have an influence. It has been noticed repeatedly that the weevil almost never attacks young pines growing in the shade of other trees, even though the shade be light. In Minnesota, while much reproduction is found in the open, it is much more commonly found under a light shade of aspen, birch, or sometimes jack pine, and often occurs in mixture with Norway pine. In the East the best stands of reproduction are pure stands in the open and a much smaller per cent is found doing well in mixture with, or in the shade of, other trees.

Ages Attacked

The first attack of the weevil occurs when the pines are from 5 to 7 years old. The first year the infestation is usually very light, but increases from year to year until the maximum is reached, when the trees are about 15 years old. From then on the amount of infestation decreases until the attack finally ceases between the 25th and 30th years.

Preferences of the Weevil

It has been the observation of all who have noticed the injurious work of this weevil that it shows a decided preference for pure stands of pine growing in the open. With increasing amounts of shade the weevil injury decreases in proportion to the density until the injury is reduced to zero under a shade such as that cast by an average stand of oak or maple.

In pure stands in the open, where its attack is most severe, the white-pine weevil shows a preference for certain trees. Suppressed trees are practically never attacked, while the greatest infestation is found among the dominant and codominant crown classes. It seems to select for attack the most thrifty and the most rapidly growing trees in a stand. This habit of selecting the best trees sometimes retards the process of natural thinning by reducing the height growth of the tallest trees and giving the backward trees the opportunity of overtaking the leaders. Sometimes in this way trees which would normally have been forced

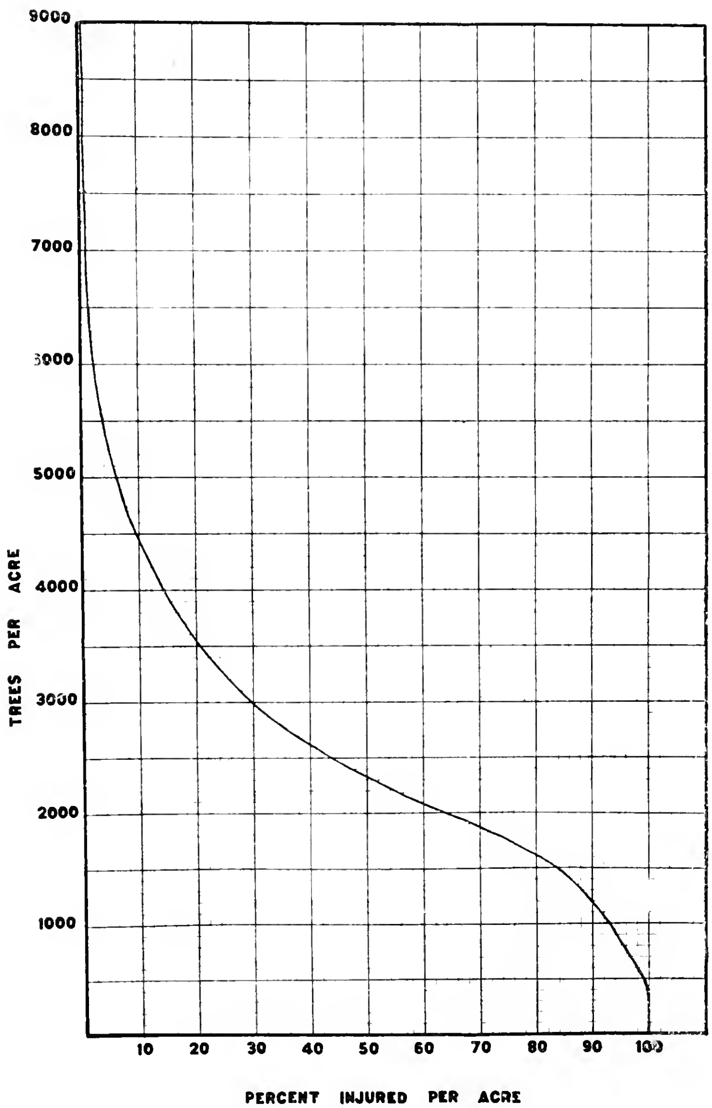

Fig. 4.—Relation of density to the per cent of trees injured per acre

out by natural selection succeed in establishing themselves as dominant trees. This interference with normal development reduces the rate of growth for the stand as a whole.

Influence of Density on the Extent of Weevil Injury

In open stands where the crowns are all free the trees are all equally subject to attack, but in the denser stands the percentage of trees suit-

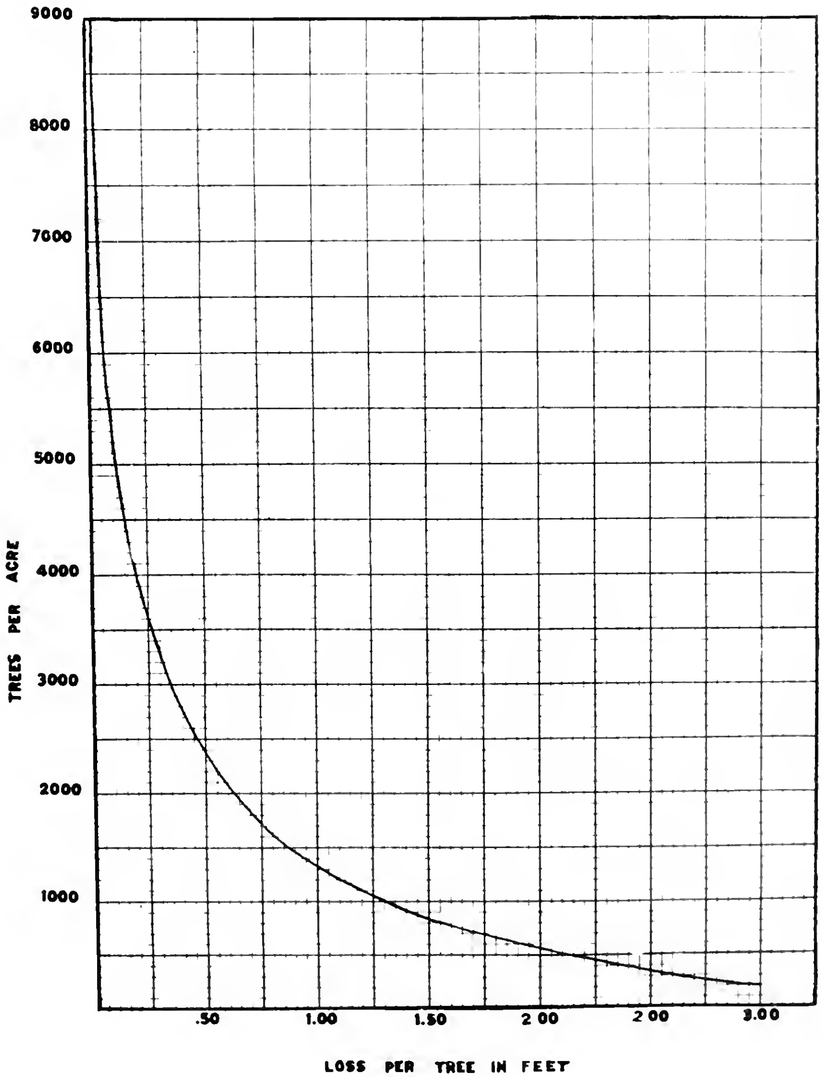

FIG. 5.—Relation of the loss per tree in height growth to the density of the stand

able for the development of the weevil becomes smaller, while in very dense stands the injury may be reduced to practically nothing.

The curve[4] shown in figure 4 illustrates this point. This curve was constructed from counts on sample plots made near Grande, in northern Isanti County, Minnesota. Up to a density of 400 trees per acre, 100 per cent are infested. Above that point the percentage infested constantly diminishes until at 4,500 per acre the infestation is slightly less than 10 per cent, while at 9,000 trees per acre the infestation is reduced to less than 1 per cent. One plot, where the trees stood 11,200 to the acre, only 0.5 per cent were infested. This plot was within 100 feet of another more open plot of the same age which had an infestation of over 50 per cent.

With this decrease in weevil attack the density increases, and with a larger number of trees per acre there is a corresponding reduction in the average loss per tree in height growth as shown in figure 5. This curve was constructed on the basis of six-inch loss in height growth for each weevil attack, which is a very conservative figure.

Density also has a direct bearing on the per cent of unmerchantable material resulting from weevil injury, as is illustrated by the curve in figure 6. This is due partly to the increased stimulus to height growth resulting from competition in the denser stands, which hastens recovery from weevil injury, and partly the crowding out of deformed and crippled trees by the healthy and vigorous individuals.

Control Measures

Several very good methods for the control of the white-pine weevil in ornamental or other small plantings have been suggested, such as spraying, collecting adults in the early spring, pruning out and burning infested shoots during June and July, and others equally impracticable under ordinary forest conditions. The most feasible of the above recommendations, that of pruning and burning weeviled shoots, cannot be done for less than $1.50 per acre each year and would necessarily have to be carried over a period of from five to ten years in order to accomplish good results. Unless regular employees can be used for this work during slack seasons, the cost is prohibitive.

From the results of this study, the most economical and effective method for controlling the weevil is by close planting. Under present Minnesota conditions the standard density of 1,210 trees per acre is dense enough to insure a final crop with few or no unmerchantable trees, although there will likely be a number with bad crooks or forks.

[4] The number of trees per acre, as shown in this and other curves in this article, represents the original number of trees before any were crowded out, and the weevil injury in each case represents the condition at the time the stand is 30 years old.

Fifteen hundred trees per acre would be much safer, and it is possible that the added stimulus to height growth would cover the difference in the cost of planting. In the East, however, where the infestation is

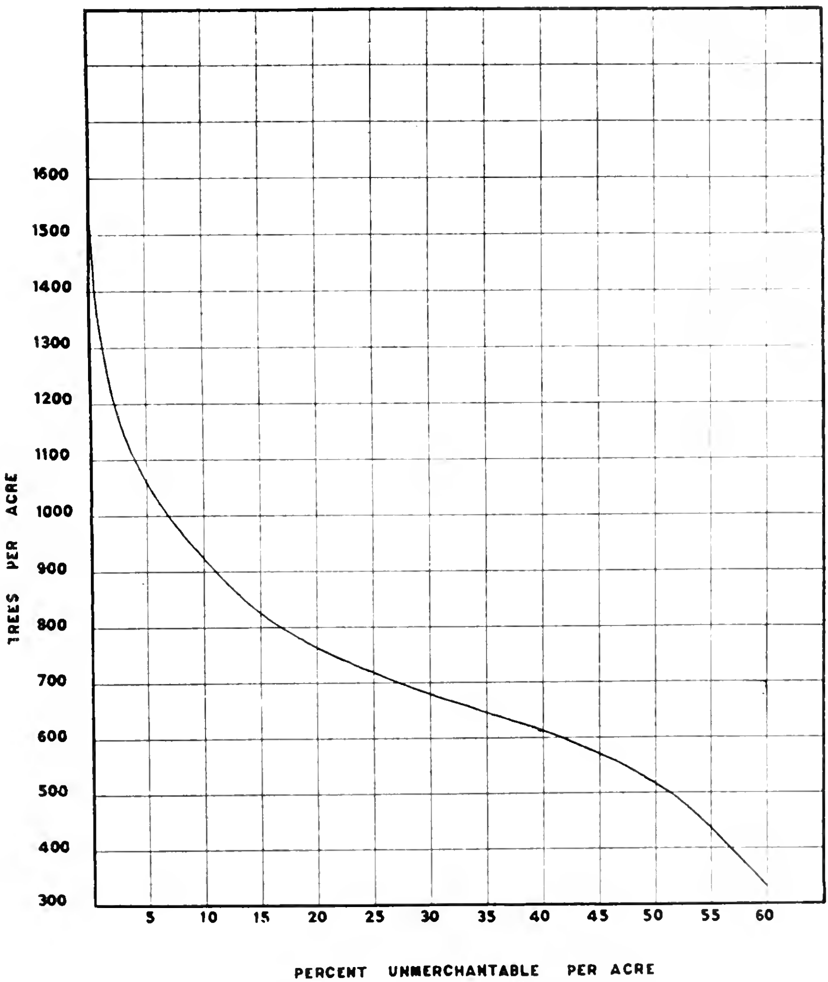

FIG. 6.—Decrease in the per cent of unmerchantable trees, resulting from weevil injury, with increasing density

much heavier, plantings should be made somewhat closer for best results. Planting 4 feet by 5 feet should be perfectly safe.

There are certain controlling agencies which can never be depended on for the complete control of the weevil, but which are present over the entire range of the insect and continually help to keep it in check. These are its parasitic and predacious enemies. Of the former, there are two species common enough to do effective work. These are *Eurytoma pissodis*, an undescribed Chalcidid parasite, the description of which will soon be published by Girault,[5] and *Lonchea rufatarsus*, a dipterous parasite. The most important predaceous enemies are birds. Such birds as the chickadee feed upon the weevil larvæ, picking them out of the infested terminals, and the ground-feeding birds, such as the ruffed grouse and the towhee, find the adults in the litter about the trees.

SUMMARY

(1) The white-pine weevil, *Pissodes strobi* Peck, injures young white pines, Norway spruce, and to a lesser extent Scotch pine, by killing the terminal shoots.

(2) The eggs are deposited during the spring and early summer in the inner bark of the terminal shoots, and the larvæ work their way downward beneath the bark, girdling the shoot. They pupate in cells in the pith or beneath the bark, emerge as adults during August and September, and hibernate in the litter beneath the trees.

(3) The weevil is distributed throughout the range of the white pine, but the infestation is heaviest in the Eastern States.

(4) Young trees between the ages of 5 and 30 years are subject to attack.

(5) The weevil prefers thrifty, rapidly growing trees in the open.

(6) Generally speaking, the denser the stand the lighter the weevil injury.

(7) The most economical and effective method of controlling the weevil in forest plantations is by close planting, although other effective measures have been suggested for ornamental plantings or small plantations.

(8) Parasites and predaceous enemies of the weevil help to keep it in check, although they can never be depended upon for the complete control of this pest.

(9) At present the white-pine weevil is not a serious pest in Minnesota, although it may become so in the future, but in the Northeastern States it is worthy of serious consideration.

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[5] The description of this species has been sent for publication to the Bulletin of the Brooklyn Entomological Society.

COMMENTS ON KORSTIAN'S CLASSIFICATION OF FORESTRY LITERATURE

By Helen E. Stockbridge, Librarian, Forest Service

As a classification of the subject of forestry, which might be applied to manuscripts or other data for which no card index is to be maintained, Mr. Korstian's outline should be useful. In a forestry library, however, even as large a one as that of the Forest Service, its application to the arrangement of the books on the shelves would hardly be practicable. In the first place, a too detailed shelf subdivision of the books on a given subject, so that only a very few books fall in each class, is unnecessary and often confusing to the library users. As Doctor Fernow has said, the classification scheme in a library corresponds to the contents of a book. It simply shows the general arrangement of the material treated, under its main divisions and subdivisions, and does not try to give in detail all of the specific subjects covered. These are brought out in the card catalogue, which corresponds to the printed index of a single volume. Just as, in consulting a book, a person would turn to the table of contents to get a general idea of how the subject is treated, so the classification scheme in a library shows how the books are arranged on the shelves. For any specific subject, however, the card index must be consulted, just as the alphabetical index of a single volume would have to be consulted to locate the minor subjects treated.

The user of a library cares very little about the arrangement of the books on the shelves, the classification scheme being useful mainly to the library staff, and to persons who wish to see in a general way what the library has along a certain line. The card index is the main dependence of the user, the place to which he turns first to find what there is in the library on a given subject, no matter how specific, or what the library has by a certain author. In the Service library he will find all the card headings arranged in one alphabet, for books, manuscripts, or articles in periodicals. This form of catalogue has been found to be more satisfactory than any other in the majority of libraries, as it is much simpler to look for a subject in its alphabetical position than to have to run through a classed arrangement before it can be found. No classification scheme could possibly bring all of the material on one subject together in one place on the shelves, especially in forestry, as so much of the literature on this subject is in the shape of articles in serial publications. The card catalogue, however, in a library like that of the Forest Service, which indexes the various forestry articles contained in its periodicals and serials separately, brings together everything the library has to offer on a given topic.

As to Mr. Korstian's suggestion of applying his scheme to a card catalogue, he probably has in mind the classed catalogue still in use in some libraries, where the cards are arranged in the drawers by classes rather than alphabetically. Mr. Korstian's subjects might be converted to the use of a dictionary catalogue, however, by rearranging them alphabetically and perhaps changing the wording of some of them so that they would fit into a dictionary arrangement.

In the Forest Service library, the classification scheme used is the one prepared by the main library of the Department of Agriculture, especially for a collection of books on agricultural and related subjects. Within the last few years this scheme has been expanded in some parts, forestry being one of the branches subdivided. There are now 27 main forestry classes, and perhaps 80 subclasses, which are found to be ample for the needs of the library and probably will be for some years to come. The subject headings used in the card catalogue, however, number several thousand, and this number is being added to all the time.

By Mary A. Ewer, Librarian, Yale School of Forestry

The article by Mr. Clarence F. Korstian on this subject, in the April number of the JOURNAL, is a very suggestive and valuable one; but the writer feels that there is still room for discussion of the proposed scheme and that to adopt it as it stands would be, in some respects, a mistake. On that account these remarks are presented, hoping that the matter may be further discussed, either in the pages of the JOURNAL or in a committee of the Society of American Foresters.

It is quite true, as Mr. Korstian says, that the classification suggested by the Yale Forest School in its Bulletin No. 1 is not detailed enough for the specialist, nor was it intended to be. But it is capable of expansion and has seen some service, at least in our own library, and therefore some criticisms of his scheme suggested by experience with ours may not be useless. These criticisms will, however, refer almost entirely to the classifying of books and pamphlets on the shelves of a library. Mr. Korstian claims that his scheme will work equally well for this or for cards in a catalogue or clippings in a file, etc., but as the requirements are somewhat different, the claim may need further examination.

I suppose it goes without saying that the main purpose of any library classification is to render all the material in the library as quickly and fully available as possible. This requires two things: First, that the scheme shall be logical and as detailed as the needs of the particular library demand; and second, that the call numbers shall be as short and simple as is practicable.

Now whether a forestry classification is or is not logical, from the forester's viewpoint, is not for a mere librarian to determine. Nevertheless I should like to make a few suggestions on the more outward phases of the question. Why should *Forest by-products,* .44 in the proposed scheme, be put in the same section with lumbering, instead of under the section on technology? Certainly the chemistry involved, if nothing else, would make it possible to place it under technology, and the already overcrowded condition of the lumbering section would make it advisable. Then Mr. Korstian has already separated Logging engineering from Forest engineering, placing the former under Lumbering (see his division .6). Why should not Camp management (see .66) likewise go under Lumbering? The lumberman at least would look for it there, as naturally as he would for logging railroads. Then put the section on Forest engineering under Forest management; taking from that section at the same time the part on Game and fish (.744) and making it, with Grazing and the section on utility of National Forests (.9711), into one section on *Other uses of forests,* which should include water-power, grazing, game refuges, hunting, all recreational uses, and whatever pertained to these uses. Or else, as is explained in the last part of this article, why not confine the number of main divisions?

As for auxiliary and related subjects, the regular Dewey system seems to me to be a kind of lazy-man's way of treating them for a forestry library. The Dewey system is arranged primarily for the needs of a large library containing material on all subjects and considering the main ones as co-ordinate parts of the sum of all human knowledge. Now when one is magnifying one subject, such as forestry, into the thing of main importance, one can no longer consider other subjects as co-ordinate with it, but literally as auxiliary. That means two things: First, that one must put all possible parts of the auxiliary subject into the main classification, as Mr. Korstian has done with Grazing, for instance, most parts of which in a general library come under the head of Animal industry; second, that one must make the classification of the auxiliary subjects themselves as simple as possible, since the forester will think of them in broad lines. And I do not think that merely selecting the main headings from the Dewey classification will make the most suitable system for this simple use.

We are using the following simplified classification for Agriculture, for instance:

- General works—
    - Bibliography
    - Biography and miscellany
    - History and education
    - Dictionaries, etc.
    - General treatises
    - Serial publications (reports, bulletins, etc.)
        - U. S. federal publications
        - States (alphabetically by States)
        - Canadian
        - Other foreign countries
- General farm practice—
    - Farm economics
    - Farm buildings
    - Agricultural physics and chemistry
    - Soil surveys
    - Clearing and reclamation of land
    - Tillage and rotation
    - Farm machinery and engineering
- Plant culture and horticulture—
    - Care of crop from seed to harvest
    - Care of product from harvest to market
    - Field and forage crops
    - Vegetables
    - Fruit culture and orchard care
    - Flowers and ornamentals
    - Pests and diseases
    - Birds, etc., as aids in agriculture
- Animal culture (most of which comes under Grazing in Forestry, and so needs little if any subdividing).

This is quite ample enough for a forestry library and is more logical for our uses than a mere condensation of a more general scheme.

So much for logical arrangement, which is the field of the forester rather than of the librarian. As to the detail necessary in any library, of course the proposed scheme, like any other workable one, can be expanded or condensed as necessary. I would only suggest this: in a general forestry library a large amount of the material consists of reports, proceedings, bulletins, and other serials, coming from a long list of countries, States, cities, societies, etc. We have found it necessary here, and I think most libraries of the kind would, to subdivide Mr. Korstian's division .06 into the following: Societies, U. S. Federal publications, State publications, British Empire publications, Other foreign countries, Cities; and we have had to further subdivide the voluminous reports of the British Empire into Canadian, Indian, Australian (including New Zealand), British Isles proper, and others. Furthermore, we have found it advisable to make a separate division altogether for periodicals, co-ordinate with forestry itself, as there are so many of them in forestry and closely related subjects.

But now as to the length of the call numbers. It is more necessary in a library to have these as short as possible than it is in a file of cards or clippings, for various reasons, and it is still more necessary in an open-shelf library, where people will be using the material who are not accustomed to carrying long numbers in their heads while diligently searching for small pamphlets. The librarian can remember longer numbers than the average user of the library, due to practice and to an immediate visualizing of the general location of the book wanted; but there is a limit, and it is annoying to all concerned to have to consult a slip of paper constantly during the search, especially among thin books and pamphlets bound in cardboard covers. Besides, the longer the numbers, the greater the chance of misplacement on the shelves and consequent unavailability.

Call numbers consist of three parts—class, author, and book numbers. The book number, however, seldom has to be remembered with the rest of the call number, because it is usually either the serial number of the publication one wants, as Bulletin No. 177, or it is the year number of a report, as 915 for 1915, or it is 1, 2, or 3, in the case of several books by the same author. These things one remembers separately and easily; therefore I leave the book number out of account. The class number (Dewey number when the Dewey system is used) is longest, obviously, when the classification is most detailed. The author or Cutter number is longest, contrariwise, when the classification is least detailed. But both class and author numbers are at their most efficient length (every bit of their length serving a useful purpose, none being wasted) and the combination is shortest, at the same time; that is, when the average minor subdivision contains a reasonable number of books, not so many as to require extremely long Cutter numbers, not so few as not to need any.

This most efficient length is as long in number of symbols, whatever the system used; but just here the writer wishes to be heretical and state that the approved systems do not always have the simplest numbers for memorizing. To give an instance: In our section containing serial publications of State forest officers and commissions, we found exceedingly long Cutter numbers necessary in the letters M and N. (How many of the readers of the JOURNAL have ever stopped to realize that one-third of the States of the Union have names beginning with M or N?) Of course, numbers from the Cutter tables would be exceedingly long under these conditions; so we arbitrarily assigned numbers from 1 to 9 to these States—for instance, M4 for Massachusetts—and then gave the serials published by Massachusetts numbers from M4 to M49. But even this did not simplify matters sufficiently in N, where the States beginning with "New" have been very prolific publishers. It was seen that four or even five figure numbers were inevitable. Consequently we tried the plan of treating "New" and "No" as if they were two others letters following N, and gave New Hampshire, for instance, the numbers from New3 to New39. Now here is the interesting fact: "New37" contains 5 symbols and so does N4958, for example; but the former is remembered more easily because it is remembered as *two* units, namely, "New" and "thirty-seven." The N followed by four decimal figures, in connection with a Dewey number of three or four places, is almost impossible to carry in the head while looking for a pamphlet; the New followed by two figures is quite possible. The advantage to memory by this change offsets any disadvantage of the possible disarrangement of alphabetic order in case of the admission of a new State whose name should begin with Nex, Ney, Nez, Ni, or Ny. Which is preliminary to saying that if this is true of the author numbers, that a combination of letters and figures may be easier to remember than a row of decimals of equal length, why may it not be true of class numbers (with all due respect and apologies to Mr. Dewey)? In other words, why necessarily make the forestry classification a Dewey Decimal one?

The writer's suggestion would be this: By all means let the Society standardize the classification, after due discussion. But why not publish the classification adopted as an outline, without Dewey numbers (they are easy enough to put in if one wishes to use them)? Again, why confine the number of main headings to 10? It seems to me that this would be a serious mistake in a young and growing science like forestry, where, almost overnight, a new minor section may spring up to the importance of a main division. Why not leave it flexible—use as many main divisions as seem important now—the number would probably be between 10 and 20—and leave it possible to elevate some of the lesser divisions or put in new ones later if it seems advisable? This need not mean that a library using the Dewey system could not use the scheme, for such could use two successive numbers at the left of the decimal point, *e. g.*, the numbers of the main divisions might run from 5.0 to 6.9 instead of from 5.0 to 5.9. Of course a general library could not so easily do this, but it would be possible without any longer numbers than the other scheme; and then most general libraries would not need very elaborate divisions anyway and could easily unite some of them and bring the number down (especially if they were using Dewey's scheme and making forestry subordinate to horticulture!).

For a further suggestion, if a commitee be appointed to prepare such a classification, why not do as the committee of the American Libraries Association on correct practice for agricultural libraries is doing—send a circular letter to every library and to every person likely to be interested, asking for copies of any scheme now in use and for suggestions? If the suggestions of a few help to improve a thing, why would not the suggestions of all be still better?

By B. E. Fernow—

The reading of the foregoing discussion suggests the need of simplifying the procedure in classifying material for a smaller library of a technical subject not intended for general public use, but for a technical clientele, and, indeed, to have classifications for various purposes.

Some 40 years ago, when the Dewey system had just made its appearance, the writer organized the technical library of a friend according to the new system; but the friend never used it, because it was too circumstantial, and by merely relying on a catchword arrangement he could help himself much more readily.

Even the most logical arrangement of the subject-matter of such a varied material as a complete forestry library contains cannot dispense with cross-referencing, for the same material viewed from different points of view falls into different classes. No two men would probably agree as to the logical position of many articles in a given scheme. Moreover, logical classification of the contents of a large subject answers one purpose, but the practical needs of a library for quickly finding a given publication may not be served by it.

The specialist, the professional user of a specialized library, does not need the logical scheme and can rely readily on a catchword system if properly cross-referenced, and a very considerable amount of library material can be handled under such a system, which, to be sure, requires the knowledge of the "key," which consists mainly of a list of the catchwords used.

The difference in the ease of use is as between a table of contents and an index. The search in a library, as in a book, is for subject-matter; it is a nuisance to first have to classify the subject instead of steering directly for it. When the library becomes too large for the catchword system, then a simple classification into broad classes may be added.

We come to the conclusion that for different purposes different classications are called for, and that it is doubtful whether a committee of the Society would be able to satisfy these various needs.

SOME SOCIAL ASPECTS OF FOREST MANAGEMENT

By Benton MacKaye

Recent symptoms of unrest among the timber workers in the Northwest and elsewhere have revealed a new problem for the American forester. It is the problem of the lumberjack. Our forest schools in their processes of turning out foresters have courses in silviculture, mensuration, dendrology, protection, influences, management, utilization, lumbering, etc; but the lumberjack himself and the very human problems that go with him do not occur in the curriculum. It may require a later age to reduce these matters to the text-book, but out in what we call "real life" they must be faced without waiting for book knowledge.

The Forest Service in its administration of the National Forests has undoubtedly done some yeoman service on the human side of the intricate problems with which it has had to deal. This is evidenced in the aid given to the "small" stockman in the use of the range, to the struggling settler in the shoestring meadows, to the "hardy prospector" on his mineral claim, and even to the lumberjack himself by providing for sanitary camps on National Forest operations. In all this the spirit has been willing, but for the most part it is *aid* rather than a *solution* which has been given. Compared with what the agriculturist has solved for the agricultural worker, how much has the forester solved for the forest worker?

The labor situation with which the nation has had to deal in the present crisis has perhaps been more acute in the lumber industry than in any other. Aside from the general causes of industrial unrest, which we will leave to the economist and the sociologist, there is one cause which is of interest to the forester. At least one basic reason for discontent among timber workers is the condition of unstable employment in the lumber industry itself. This is something that every forester knows. He knows also that this condition will continue so long as the forest industry is conducted as one of harvesting or "mining" timber and not of reproducing and cropping timber.

Foresters have long preached timber cropping *versus* timber mining. We have pointed out over and over again the present damage and the future danger of a depleted timber supply, of unregulated streamflow, and of other so-called economic maladjustments. It is true also that the point has been made from time to time that the practice of forestry will tend to stabilize forest employment and to make for permanent community life. Compared, however, with the efforts made to advance forestry for the benefit of the consumer and the business interests of the country, how much have we done as to the social results of an industry of homeless men?

Stable employment and community life will not, of course—even under forestry—come about of their own accord. These are things which must be deliberately worked for. A crucial point here, with respect to forest management, is the size of the working circle. It may make little difference, from the standpoint of timber supply, whether the working circle occupies a township or a State, but from the standpoint of the worker it makes all the difference in the world. If he can reach the same spot at the end of each day, he can establish a home there and a family life; but if he cannot reach the one spot, he must live in a camp and will then soon establish a hobo life.

In forest management in which the working circle is based on the needs of the workers (consistently, of course, with the needs of efficient operation) there would be two kinds of forest communities. One of these would be supported by the sawmill operation and the other by the logging operation. From the standpoint of what is physically possible, a sawmill located on a suitable site could, under a proper system of forest management, be continuously supplied with timber from the growth on land tributary; and the sawmill community could remain permanently on one location. The headquarters of the logging operation, however, could not always be planned so as to remain on one site, and so the logging community might have to be relocated from time to time.

It is of course highly desirable that the logging community be relocated as seldom as possible. The greater the daily working radius from a given point, the longer can the headquarters remain at that point and the fewer will be the movings of the community during a rotation. Consequently special effort should be made to increase the daily working distance through improved transportation. This is simply the commuter's problem as applied to forest management.

There is another problem beside that of commuting in connection with the logging community. This is the matter of organizing the community so that it will not fall apart when—every 10 or 20 years—it may have to be relocated. If it is to preserve its integrity and be something more than a "shack town," the logging community must be developed so as to meet certain definite standards: The first of these is self-government. Provision for securing at all times the opportunity for the people of the forest community to vote, wherever located, should be made one of the important features of the forest working plan. Educational facilities also go without saying; the school-house, as well as the voting booth, should follow the community. Finally comes the very practical need of providing co-operative facilities to the community's occupants for securing their economic welfare. If the agricultural worker, through co-operative marketing of farm produce, is aided by public agencies to sell his labor power, then the forest worker is entitled to similar aid in selling *his* labor power. On the basis of a timber-cropping system it should be no difficult task to organize a community to meet these standards, and once so organized it will hold its integrity through any number of relocations.

Timber cropping as against timber mining requires a dependable and long-time form of ownership. Generally speaking, forestry must go with public ownership or control. The opportunities in this country for this sort of control exist most extensively in the 150 million acres of National Forests.

The productive parts of the typical National Forest in the West consist very largely of a patchwork of public and private holdings. And if a consistent and rational forest management is to be established on this patchwork—with the social aspects in mind—then some form of co-operation must be effected between the various private interests involved and the public interests represented by the respective State governments and the Federal Government. The working circle within the National Forest—if it is to work—must be a unit and not, like the wandering minstrel, "a thing of shreds and patches." In short, the interests involved must be integrated.

It so happens that the suggestions most loudly voiced with regard to a change in present National Forest policies are based upon the very opposite idea from the one above discussed. Strong pressure is ever working, within Congress and outside, to get the Forests "thrown open to entry." Various clever means have been devised, based on all sorts of excuses, for honeycombing still further what remains of the nation's common property in the National Forests. The policy here propounded, and to some extent applied, is one not of integration but of disintegration.

One of the big problems, then, affecting the social aspects of forest management is that of developing integral working units within the National Forests. This may be done either through government purchase (to a very limited extent) of enclosed private holdings, or through substitution of timber bonds, or by some form of co-operative control. The details involved in these different methods require too much space to be taken up in this paper.

Another big question affecting conditions here discussed is that of initiative in National Forest management. At present the lumber company, rather than the Government, seems to take the initiative. The company backs a sawmill up against a Forest and makes its plans for cutting the timber on its privately owned patches within or adjacent to the Forest boundary. It then makes a proposition to the Government to buy the latter's timber wherever it can be taken out along with its own. The company may also buy a strip of Government stumpage independently from its own holdings. The timber-sale contract provides for silviculture in the cuttings and for sanitation in the camps. But whatever "working plan" is made is made by the company, and the Government follows rather than leads.

The Government in the present crisis, and in view of labor difficulties, has already considered taking part directly in the operation of Sitka spruce for army airplane stock. By means of this policy of direct operation, working plans for carefully chosen units, made *not* by the lumber companies but by the Government itself, might be carried out in cases where such plans could not be applied through timber-sale contracts. By this means the social and labor aspects of forest management could be provided for. The main problem here is one in marketing the lumber when cut. It is recognized that much of the Government timber is not readily accessible. On the other hand, much of it is accessible and more of it will be within the next few years. In view of the present and prospective needs for lumber and forest products for national purposes, it would seem that it might "pay" the Government to take the initiative in the management of its own timber Especially is this so in view of the unsolved and menacing labor problems which are involved.

But after all, it may be asked, are not these problems for the legislator to decide rather than the forester? If so, the same holds true for the establishment of the National Forests in the first place, for the establishment of State foresters and fire-protection systems, and for most of what has been done in State and nation to build up a system of forestry. In this development foresters should take, and they have taken, the lead. This, in fact, is the main job of the profession. Directly or indirectly, it is for us to put forestry on the map and to keep it there.

And if we desire to have a system of forestry in this country which is concerned only with wood supply, streamflow, and their *material* by-products, then we should pay no attention to the social aspects of forest management. But if we pursue this policy we must not be surprised in future times of crisis if the labor situation, in the industry which is ultimately in our charge, becomes acute and grows worse instead of better; for fundamentally it will be "up to us" for our failure to prepare.

GROWTH AND MANAGEMENT OF PIÑON IN NEW MEXICO

By Herman H. Chapman and C. E. Behre

But little scientific data is at hand to show the growth and possibilities of management of piñon (*Pinus edulis*) in the Southwest. C. E. Behre recently collected growth data on 14 trees on the Santa Fe National Forest, near Glorieta, to determine approximately the period required to produce a mining prop 6 to 8 feet long and 4 inches at top.

The trees grew in a typical piñon site on the top and south slope of a dry, rocky ridge with coarse, gravelly, dry, and shallow soil, underlaid with sandstone and no ground cover or underbrush, at an altitude of 7,000 feet. As the trees analyzed had been cut for props, the measurements were confined to the taking of stump height, diameter inside bark, and age of stump and the length of prop or section, with it's age and diameter inside bark at the top end. The total height of the tree was also obtained by measuring the length of unused top.

Because of the exceedingly slow growth of the piñon and the difficulty of exact counts of the rings, even with a glass, no attempt was made to measure the rings by decades; but a total count sufficed, and this was taken as the average of the results of two counts, unless differences greater than one decade were shown. This figure was then reduced to terms of numbers of years required to grow one inch at stump and at top of prop.

Height growth between stump and top cut was obtained by dividing length by difference in age of the stump and top sections and from total height on total age. The period required to reach stump height was obtained by analyzing a few seedlings.

Average taper was found to be 1 inch for 7 feet in length, for the merchantable bole. From curves of diameter growth at stump, and this figure for taper, the conclusion was reached that a tree measuring 4.86 inches on the stump would give a prop 4 inches at top and 6 feet long at the age of 150 years, 15 years of which are required for the seedling to grow to stump height of 10 inches, and that an 8-foot prop 4 inches at top would require 155 years. Twelve feet of merchantable length, or two 6-foot props, require 170 years total age. Thus a rotation of 170 years would double the yield of props as against 150 years, provided all trees grew straight enough to yield the required dimensions, which is not usually the case.

Piñon grows very slowly throughout its life. The rate of diameter growth, however, seems to increase with age until the tree reaches merchantable size. The height growth increases at first, but after about 40 years appears to remain about constant until well over 100 years, when it begins to fall off.

Like all species accustomed to arid conditions, piñon grows far more rapidly on sites supplied with a deeper soil, capable of storing moisture, than on rocky, dry sites. Its response to cultivation, as shown in the arboretum at the Fort Bayard Nursery, is remarkable; yet it must be classed as a slow grower, and its value, in comparison with the more important timber trees, rests chiefly on its ability to resist extremes of transpiration caused by drouth, heat, and wind, which render the growing of yellow pine impossible. Were it not for the piñon and the juniper species, the range of our woody vegetation throughout the West would shrink perhaps one-half, and a supply of cordwood, now easily accessible and of good quality, would be lacking.

The rate of growth of juniper probably does not exceed that of piñon. As an offset to this slowness of development we must remember that most of the land on which these species grow is non-irrigable, rough, and utterly worthless for agriculture. The cost of administering such areas is low, fire protection is not a serious problem, and the revenue from grazing can be made to carry all the expenses of administration.

Reproduction is usually sufficient to replace the stand, especially if a diameter limit is placed upon the trees to be removed coincident with the production of prop sizes, or, in the case of juniper, of 10 to 12 inches on the stump. The retention and management of this type within National Forests may not yield a large revenue per acre in the long run, but what it does yield is almost clear profit. The product, cordwood and mining timbers, will always be in demand, and in seasons like the present, where coal shortages are threatened, local communities may be forced to depend largely on this type for fire-wood.

The forest values of the piñon and juniper abundantly justify the retention and management of the type.

TABLE 1.—*Age of Piñon at Different Diameters on Stump, Including Age of Seedling as 15 Years. Stump Height, 10 Inches*

[Based on Fourteen Trees Measured in T. 16 N., R. 11 E., New Mexico Principal Meridian, within the Santa Fe National Forest]

D. i. b. stump (*inches*)	Age of tree (*years*)
1	50
2	80
3	105
4	130
5	150
6	170
7	185
8	195
9	205
10	220
11	230

TABLE 2.—*Height Growth of Piñon Seedlings*

[Based on Six Trees]

Height (*inches*)	Age (*years*)
4	8
6	11
8	13
10	15
12	17

TABLE 3.—*Height Growth of Piñon*

[Based on Ten Trees]

Age (*years*)	Height (*feet*)
20	1.5
40	4.0
60	6.5
80	9.0
100	12
120	15
140	18
160	21
180	23
200	26
220	28
240	31

WOODLAND VERSUS WOODLOT IN FARM FORESTRY

By Wilbur R. Mattoon

Forestry Extension Specialist[1]

Some one once remarked, in discussing a proposed change in a certain custom, " 'Taint my business to kick the animal." Sometimes, however, it is better to raise a question—to kick, if you please—rather than to continue the use of a clumsy word or impractical method. The author desires to question the use of the word "woodlot," as commonly employed by State and Federal forestry workers to cover all kinds of farm woodland, besides various phases of farm forestry. It often inadequately describes the character of the timber distribution. The wooded lands on farms over a large portion of the United States east of the Mississippi River lie mostly in irregluarly shaped tracts covering the hills and ridges and reaching out over stony, steep, wet, and poor lands. These find adequate description in the terms "woodland" or "farm woodlands."

A parallel of "woodlot" and "woodland" is found in "pasture lot" and "pasture land," the one being specific and the other generic. Our farms for the most part comprise the three classes of (1) tillable or "agricultural" land, (2) pasture land, and (3) woodland. Doubtless not a few readers will recall having had the experience of feeling the inadequacy of the specific word "woodlot" when dealing broadly with the woodland on farms. Department of Agriculture Bulletin 481, "The Status and Value of Farm Woodlots in the Eastern United States,"[2] does not consider individual woodlots, but does deal broadly with the farm woodland of the region. The use of the word "woodland" in the bulletin would have greatly helped the publication in reaching the people outside the small circle of teachers and other professional workers. A broader and better title for Farmers' Bulletin 715[3] would have been "Measuring and Marketing Farm Timber."

Many months of field work in farm forestry in 16 States, from Lake Erie to the Gulf of Mexico, have convinced the author that over much of the Eastern United States the word "woodlot" is not only a poor

[1] Forest Service in co-operation with States Relations Service, Washington, D. C.

[2] By E. H. Frothingham.

[3] "Measuring and Marketing Woodlot Products," by W. R. Mattoon and W. B. Barrows.

choice, but in reality a stumbling block in the path of progress in this important phase of forestry work. It is a word of restricted meaning and, while a standard word in the profession, it is neither generally acceptable to the people nor in general use among them. The strong movement of the forest worker to reach the people through personal touch with the man on the farm, as well as by publications, emphasizes the need for using simple, expressive, often local words for the things he is dealing with. The use of strange or ill-fitting terms tends to separate the worker from his hearer and carries the impression that "he is not of my kind."

The term "woodlot" appears to have sprung from New England. That it was early considered as specific in character is shown in the title of Forest Service Bulletin 42, "The Woodlot: A Handbook for Owners of Woodlands in Southern New England."[4] The influence of New England as a field for early work and the home of a good quota of forestry workers likely accounts for the present usage of the word and its practical replacement of the generic term woodland. Unfortunately the word "woodlot" to many farmers not only suggests "pasture lot," but "hog lot" as well. When employed to refer to a relatively small area of farm woodland with a more or less rectangular or regular outline, the word "woodlot" has a field of distinctive usefulness. In the States lying east of the Mississippi and south of the Potomac and Ohio rivers, the "prevailing idea suggested by the word 'woodlot' is that of a small, openly wooded enclosure near the barn where calves and hogs are turned out for shade."[5] In Alabama, according to Professor Price, who handled the course in farm forestry last year in the Alabama Polytechnic Institute, "the boys make fun of the word 'woodlot'; they think it is the place in the back yard where firewood is hauled and piled up for the year's supply." The terms most commonly heard throughout the region are "woods," "woodlands," "timber," and "timberland." These words are all broad in their meaning.

In Iowa and other States in that region, according to the results of investigation, the people refer to their native forest growth as "timber," and to planted stands as "planted timber." The word "woodlot" is seldom used. It is doubtful whether the farmers in much of New England, New York, and Pennsylvania actually use "woodlot" in preference to "woods" or "timber" in referring to a specified tract of their woodland. Farms lying within the richer, heavily cleared, and worked sections of the East might easily be an exception, due to the occurrence

[5] I. W. Hill, in charge of Boys' Club Work in the South, States Relations Service.

of the woods in the form of small, mostly isolated, and fenced tracts. Examples would be sections of the Connecticut and Cumberland valleys, the region lying east of Buffalo, N. Y., the blue grass regions of Kentucky and Tennessee, and the "black prairie" of Alabama and Mississippi. Generally, however, while the forester has been talking and writing about the woodlot, the owners and users of wooded or timbered portions of farms in most regions have been using other names for them. In very many instances "woodlot" is a misfit.

"Farm forestry" is an expressive and dignified term and should largely replace the current term "woodlot forestry." The former includes broadly all phases of forestry for the farm, such as the planting of trees for windbreaks and reclaiming eroded or gullied lands, the care and improvement of farm woodland—whether small sized or larger irregular woodland areas—and the production, utilization, and marketing of farm timber. One could appropriately speak, for example, of the method of handling a certain woodlot, when referring to a woods of small area and regular shape, but to refer collectively to all the wooded farm land in a region or a State as "woodlots" rather than "woodland" seems decidedly a poor usage of words. Other generic terms to be considered in this connection are "woods," "woodland products," "farm timber," or "forest products from farm woodlands." Why not place the word "woods" in our every-day forestry literature? It is short and expressive and is the word most widely used by the people in referring to the wooded portions of farms.

The views here expressed were set forth by the author during the past spring (1917) and have already received the personal endorsement of many workers in farm forestry in the eastern United States. It seems worth while to make sure that the terms used in connection with promoting forestry in agriculture be such as to convey adequately the breadth and importance of the subject and effectively reach the people.

REVIEWS

Marketing Farm Woodlot Products in Georgia. By George N. Lamb, Forest Examiner, U. S. Forest Service. Bulletin 129, Georgia State College of Agriculture.

According to the author, there are three natural forest regions in Georgia—the mountain region, occupying the northern part of the State; the Piedmont region, extending south to Columbus and Augusta, in the central part of the State, and the coastal plain, extending to the ocean. The northern region is rough and mountainous, from 41 to 79 per cent of the farms being timbered. The large size of the farm woodlot will always make woodlot products in this region of immense value. There is a market for tanbark, posts, ties, cordwood, poles, and sawlogs. Shortleaf pine and the oaks make up the major portion of the stands. The railroads running north and south between mountain ridges make transportation facilities poor and necessitate shipping long distances to the markets, which lie mostly to the south.

In the Piedmont region the lands are rolling and the soil fertile. The farm woodlots occupy on the average 35.4 per cent of the farms. Various southern pines and oaks work up the most of the stands. But little timber is shipped from this region, there being a good market for most products. The coastal-plain region is comparatively level. The proportion of woodlots in farms runs from 21 per cent to 91 per cent, varying in different portions. Pines, oak, and hickory make up the principal stands in the upland and cypress and gum the principal swamp stands. There is a good market for all products from woodlots.

The important commercial species are listed together with the products into which each can be manufactured by the woodlot owner. The industries utilizing products from the woodlots are taken up and a description of the products, as to size and form, is given; also prices for 1916. This information is gathered together into a comprehensive table showing the principal kinds of woods and the industries that use different products. The Doyle Rule and the Scribner Decimal C Rule are printed in full, the Doyle-Scribner Rule being in common in Georgia. The market values of various kinds of woods in different forms are given for the year 1916 and also stumpage prices of timber.

Since it is often necessary in marketing woodlot products to ship by rail, often long distances, tables are printed showing the minimum weights per car allowed for different woodlot products, the approximate weight of 1,000 board feet of green logs of different species measuring 18 inches in diameter, the average amount of woodlot products that may be loaded on a freight car, and the rate per carload for different distances.

The author also discusses a simple method of estimating trees in board feet by determining the diameters and length of logs in the tree and finding the board feet from a log table. He also discusses how and where to sell the timber in the woodlot and states the advisability of using a written contract.

J. A. F.

Farm Woodlot Timber: Its Uses and Principal Markets. By George N. Lamb, Forest Examiner, U. S. Forest Service. Extension Bulletin 51, Department of Agriculture Extension, Purdue University, Indiana.

According to the Tenth Census, the 215,485 farms in Indiana produced $5,603,000 in woodlot products. This amounts to $26 per farm. There are 3,370,791 acres in woodlands, an average of 15.6 acres per farm. The average annual income per acre of woodland from woodlot products is therefore $1.67.

Between 50 and 60 species are commercially important in Indiana, although all are not marketed separately as lumber or other forest products. In the northern half of the State beech, sugar maple, and white oak make up the major part of the upland stand, together with basswood, yellow poplar, hickory, and ash. Through heavy cutting, the percentage of white oak has been heavily reduced. The species typical of the bottomlands are elm, soft maple, black walnut, hickory, hackberry, sycamore, pin oak, and burr oak. Between these two types large areas are found where any combination of these species may be seen.

In the southern half of the State the typical upland areas support a white-black oak type with maple, beech, basswood, yellow poplar, chestnut, and chestnut oak in mixture. Pine is found in the rougher lands. Red gum and black gum mixed with elm are the chief species in the lowlands.

The author lists 17 species of chief commercial importance from the standpoint of the woodlot owner, and describes for each the possible markets for different kinds of logs and other material and the distance which it is practical to ship different products. He notes the chief industries demanding woodlot timber and their requirements as to kinds and sizes, such as saw timber, veneer wood, fuel wood, railroad ties, mine timbers, posts, piling, handle wood, vehicle parts, cooperage stock, excelsior, furniture, and tanbark. The prices given are for the year 1915-1916. In 1915 there were 700 sawmills well distributed in the State, so that few localities were without one.

In selling logs three grades are recognized—No. 1 (good logs), No. 2 (common), and No. 3 (culls). At some points it is the practice to buy logs tree run at the price of common logs. The author shows that the grading of the logs for sale will net the owner one-third more than where they are sold at the average price for the tree run. This is because good logs often run as high as 67 per cent and cull logs only 11 per cent.

The Doyle Rule for finding the contents of logs is printed. Figures are given to show the cost of manufacturing and marketing logs and ties. At the end of the bulletin sixteen suggestions are given to guide in marketing woodlot products.

J. A. F.

Marketing Farm Woodlot Products in Maine. By George N. Lamb, Forest Examiner, U. S. Forest Service. Extension Bulletin 113, University of Maine.

A series of bulletins on the marketing of woodlot products is being issued by the U. S. Forest Service in co-operation with different woodlot States. These bulletins in general list the products produced by farm woodlots, give the form and size of products demanded by the market, and make suggestions as to the best methods of marketing. However skillful farmers are in the growing and marketing of agricultural products, they have shown a lack of knowledge as to how to manufacture and dispose of their woodlot products to the best advantage. This has been due largely to a lack of information on the subject. Issued at a time when there is increased demand for woodlot products, these bulletins should enable the woodlot owner to work up his timber into products that will secure the highest returns.

The U. S. Census of 1910 gives the value of woodlot products in Maine as $5,626,900, an average annual return per farm woodlot of $134. This is 14.2 per cent of the total value of farm crops, or third among the crops produced in the State. There are 2,775,021 acres of woodland in the 60,016 farms. The decrease of 3.9 per cent of lands in farms in the last 30 years and a decrease of 32.3 per cent improved land on the farms show that the woodlot will continue to be a very important part of Maine farms.

The author lists eight conifers as indigenous to Maine, of which white pine, red spruce, and balsam fir are the most common, and 25 hardwoods, of which yellow and paper birch, sugar maple, beech, and poplar are the most important growth. Of these hardwoods, 12 are found only in the southwestern part of the State or as isolated specimens.

The important trees are arranged in two groups, under the headings "fast" and "slow" growth, white pine, red pine, white spruce, poplar, tamarack, paper birch, soft maple, white ash, red oak, basswood, and white elm being listed as fast growth. The important species are also arranged in tabular form, giving the special and general uses for each species. No other State puts its trees to a wider variety of uses than does Maine.

Methods of estimating timber by the cord and by board feet for both softwoods and hardwoods are described. The trees are counted and classified according to diameters and the contents in cords or in board feet found from a table which shows the number of trees of different diameters necessary to make a cord of 4-foot wood, or 1,000 board feet. The table is taken in part from Farmers' Bulletin 715. A second method of estimating trees by board feet is by the use of the 18-foot pole and cross-piece dendrometer, by means of which the diameter at the top of the first 16-foot log can be obtained very accurately. The diameter of the upper logs can be obtained by comparison with the top diameter of the butt log. The Maine, or Holland, Rule is printed for finding the contents of the logs in board feet. For finding the height of trees or the number of logs, the author suggests a most practical method. A diagram is given for a hypsometer, based on the Faustman instrument, that can be cut out and tacked on a block of wood for use.

The different methods of selling timber from the woodlot are described, the sale of cut products being recommended, either paid for on delivery by the owner of material cut by himself or on the scale of products cut in his woodlot by the buyer. Attention is called to the necessity for an agreement in writing, even on small sales, and the essential conditions of a complete contract are given. The advantage of co-operation in cutting, marketing, and shipping the products of the woodlot by several neighboring farmers is noted.

The remainder of the bulletin, probably the most important part to the woodlot owner, discusses 48 different woodlot products that are in demand in the State. Of these, 23 are discussed in detail. For the different products are given specifications as to size, conditions, and kinds of woods demanded by the market, methods of disposal, and the market value in 1916.

J. A. F.

Nursery Practice on the National Forests. By C. R. Tillotson. Bulletin No. 479, U. S. Department of Agriculture, May, 1917. 86 pp.

Serious efforts in nursery practice and planting on the National Forests date from 1905, when these forests were transferred from the Department of the Interior to the Department of Agriculture and placed under direct control of the National Forest Service. After passing through a period of various vicissitudes due to overconfidence and lack of experience, artificial regeneration has steadily improved, until today it is upon a well-established economic basis. At the present time about 10,000,000 seedlings and transplants are required annually for planting on the National Forests. Tillotson, in the bulletin under review, has brought together the most useful of the experience gained during the past 12 to 15 years in the many National Forest nurseries. The bulletin presents the results of the study and experience of many different members of the Forest Service, compiled, weighed, and harmonized by the author. As it is a treatise on the present nursery practice on the National Forests, based upon extensive experiments and experience, it should prove of value and interest to all who are operating or are employed in forest nurseries.

The topics included and their order of presentation are: (1) Introduction, (2) Factors influencing the selection of a nursery site, (3) Size and arrangement of nursery, (4) Outfit, (5) Nursery operations, (6) Removal of nursery stock from nursery, (7) Diseases and injuries in nursery, (8) Fertilizers, (9) Cost of operations.

Under factors influencing the selection of a nursery site, special emphasis is attached to available water supply, quality of the soil, accessibility, species to be raised, and the climate. The author states: "At the Savenac Nursery, where ditch irrigation is practiced; at the Bessey Nursery, where flooding of the beds is practiced, and at the Wind River Nursery, where garden sprinklers are used exclusively, about 4,800, 225, and 75 gallons, respectively, of water per minute are available. The yearly capacity of the nurseries is 4,000,000, 2,000,000, and 2,000,000 plants, and the areas actually occupied by nursery stock are 15, 3, and 4 acres, respectively." The above appears to show that sprinkling is advantageous when the water supply is barely sufficient for the best results.

Forest Service experience has not indicated that the nursery soil should be similar to the planting site, especially when that is poor. It has shown that the best results can be obtained on a soil with a sandy foundation, particularly a sandy loam of good depth—fresh, friable, and fertile. Slope and exposure are of little import in most instances, as nurseries should be located on level ground or where the slope is slight. The author does well to emphasize the relation of climate to the location of the nursery, because serious mistakes have been made in the past. The nursery should be located where the climatic conditions are very similar to those of the planting sites, in order that the stock may be in a dormant condition during the planting season in autumn and spring. When climatic conditions are not similar, stock must be shipped from the nursery in the spring, while the planting site is still covered with snow, or else held at the nursery until growth has started.

The relative merits of small and large nurseries have not been definitely determined by the Forest Service; each possesses certain advantages over the other. Although the concentration of the work at large nurseries makes for efficient management, good stock, and low cost of production, there is a decided advantage in growing plants near the areas where they are to be planted; furthermore, insect and fungus troubles are not likely to cause disastrous results.

Tables show the area of seed bed and of transplant bed necessary to produce 1,000,000 seedlings and transplants, respectively, at various spacings, and on page 27 an excellent table shows the actual number of seedlings of various species and age classes that one should aim to grow per unit of area. In the rather full discussion of the outfit necessary for equipping a forest nursery, particularly for the distribution of water, it is rather surprising that the efficient and economical Skinner overhead system of irrigation is not mentioned, probably due to its not being used at any of the nurseries maintained by the Forest Service. An efficient nursery windbreak is illustrated, and is described as follows: Two parallel rows of slatting are attached to both sides of a row of posts and the space between stuffed with hay.

The larger part of the bulletin is given to the details of nursery practice, from the preparation of the nursery site to the lifting of the stock. Although this part contains nothing revolutionary in nursery practice, it is an excellent summary of present-day nursery practice not only in the Forest Service, but in State and private forest nurseries as well. In the discussion of shading the seed beds a detailed account is given of the species grown at the different national nurseries that experience has shown can be grown without shade and those that require shade for a few weeks or longer.

A table on page 49 shows the classes of transplants produced of different species at 13 national nurseries. In transplanting at the Forest Service nurseries the spacing is usually not greater than 1½ inches in the rows and 6 inches between the rows. The author states that the common error is to space plants more widely than is necessary. The reviewer agrees with the above statement, but finds from his own experience in New England that the cost of hand labor is much reduced by a 1-inch spacing in the rows and 8 to 10 inches between the rows. By having the transplant beds 100 feet in length and equally wide, or even wider, hand cultivators almost completely replace the hoe in cultivation.

The test of efficient nursery practice is the quality and cost of the stock. In a country as large as the United States, with divers climatic and soil conditions and great variation in the quality and cost of labor, nursery practice cannot be uniform. The methods that apply in one locality are often not entirely applicable in another. As a bulletin of value and intended for those engaged in nursery work in all parts of the country, greater emphasis might well have been placed upon the fact that definite rules of procedure and definite methods of practice must be determined for each nursery separately. Although general principles apply alike in one part of the country as well as in another, the superintendent of a forest nursery who grows the best stock at the least cost must be familiar with a wide variation in practice that he may utilize the best for his particular locality, or even create new methods and new practices that save cost or result in better stock. The contents of the bulletin are well arranged and a number of well-chosen photographs and line drawings illustrate the text.

J. W. T.

A few comments by one interested in fertilizers may be also of interest. In discussing phosphoric acid fertilizers mention is made of bone meal and thomas meal, whereas acid phosphate (plain superphosphate) is a highly efficient source of phosphoric acid, and it ought in many respects be much better adapted to certain uses in the nursery than either of the materials mentioned. Furthermore, there is danger, in the case of the thomas meal or slag, that there would be so much lime present as to interfere with the growth of certain pines or other coniferous trees, whereas perhaps for other seedlings the lime might be helpful.

Again, on page 82, in speaking of slaking lime, the author speaks of "pouring over it" the water; this, I think, should be modified to read, "sprinkling over it very gradually." If the water were poured on as suggested, most of it would run off the lime and conditions would not be so ideal for slaking.

On page 83 I notice a typographical error. The word serradella is spelled seradilla. Again, on page 83, I notice the author speaks of fungi which live in a symbiotic relation with the roots of leguminous plants. Are they bacteria (Pseudomonas), and did the author have in mind when writing it the mycorrhiza, which seem to be important in connection with the growth of some of the leguminosæ?

On page 84 a statement is made that lime does not improve loose soils, whereas it is generally claimed that it does if used in moderate quantities and in suitable form. It has also been claimed in Europe that acid phosphate exerts an important flocculating effect upon clay soils, and this is an important constituent of commercial fertilizers; hence it would appear probable that commercial fertilizers containing it would improve the texture of clay soils. Furthermore, not all commercial fertilizers are as subject to leaching as would be inferred from the statement, as they vary very widely in this particular.

On page 85 the nodules on soy-beans are spoken of as being larger than on cowpeas. As I read it, I thought the inference intended was that consequently more nitrogen was gathered by them. If my memory serves me correctly, my observations, together with those of many other investigators, are to the effect that when the inoculation is somewhat imperfect larger nodules developed than otherwise, yet with more perfect inoculation there may be greater nitrogen assimilation.

H. J. W.

The Kiln Drying of Lumber. By H. D. Tiemann. J. B. Lippincott Co., Philadelphia. 1917. Pp. 316. Illus. Price, $4.

This is an exceedingly timely volume dealing with a subject now of paramount importance to the United States and her allies because of the immediate demand for vast quantities of certain woods for military purposes.

The principles of scientific kiln-drying of wood worked out by the author have resulted in the perfection of a dry kiln which has been adopted as the standard for seasoning the immense quantity of spruce required for the carrying out of our airplane program, for black walnut and other woods for gun-stocks, and for woods used in shipbuilding. Under former methods of operation the satisfactory artificial seasoning of these woods in a short time was impossible.

The book treats in a comprehensive way of the structure and properties of wood, the physical changes that occur during the process of drying, present practices in vogue at sawmills and woodworking plants, principles of kiln-drying, the construction and operation of the water-spray humidity-regulated dry kiln, and a discussion of the methods and practices to be followed in handling various woods, especially refractory ones. The author points out that the present drying practices at lumber manufacturing and woodworking plants vary enormously, there being no standard even for given species and given types of kilns. The results, therefore, on the whole have been reasonably satisfactory only with woods which because of their simple physical structure lend themselves readily to crude methods.

There is a vast amount of information in the book that is extremely valuable to any one interested in seasoning lumber by artificial means, whether lumberman, scientist, engineer, or forester. If the principles laid down by the author were followed by sawmill men generally, whether handling softwoods or hardwoods, a vast saving in lumber values would follow, because there is no phase of lumber manufacture which is conducted on so unscientific a basis as the artificial seasoning of lumber.

The author, who is the leading authority in the United States on lumber seasoning, has devoted the major portion of his time in recent years to the study of this problem, and as a nation we owe much to him, since the results of his work will be one of the vital factors which will enable the allies to control the aërial operations over the European battlefields—an essential to an allied victory. We may, therefore, regard this volume as one of the most valuable contributions to our technical literature that has yet appeared.

R. C. B.

Tannin Content of Pacific Coast Trees. H. K. Benson and F. M. Jones. Jour. Ind. and Eng. Chemistry, December, 1917. Pp. 1096-1098.

In a study of the tannin content of western tree species made at the chemical engineering laboratories of the University of Washington, it was found that the tannin content of a sample of Douglas-fir slabwood increased after storing for one year from 5.92 per cent to 7.5 per cent, or an increase of 1.6 per cent, while the total solids increased 0.9 per cent and the non-tannins decreased 0.9 per cent. Western larch bark gave a surprisingly high yield of tannin, 10.6 per cent, as did western yellow-pine bark, with a yield of 10.9 per cent. Western hemlock bark yielded 10.93 per cent of tannins, which is less than has been reported by other investigators and practical tanners. The bark of a number of indigenous broadleaved species was also tested, dogwood bark yielding 1.6 per cent, cottonwood bark 4.7 per cent, and red alder bark 3.3 per cent; but the value of the extracts from these three barks is rather doubtful. The dogwood extract seems to be of some possible value as a dye, but no mordant for this dye is suggested in the article.

B. L. G.

Annual Report of the Director of Forestry of the Philippine Islands. Fiscal year ended December 31, 1916. Manila, 1917. Pp. 83.

Progress in forest work of many kinds is recorded in this report, especially along the lines of trail mapping, forest surveys, reforestation, and the establishment of forest zones and commercial forests.

The importance of the trail work can scarcely be realized by one unfamiliar with conditions in the islands. During the early days of the American occupation there were practically no maps of the forest areas, and when the Bureau of Forestry began its work it was impossible to locate logging areas without a survey from some known point on the coast. In fact, large areas of forest had never been penetrated by white men. Although army engineers mapped many areas adjacent to military posts, it was left largely to foresters to penetrate and roughly map the interior forest areas—a work which was early started by the Bureau.

The present report shows that 7,500 kilometers of trail notes have been filed in the Manila office, and notes for 1,700 additional kilometers are pending. More than 5,000 kilometers of trail notes have been plotted on the base maps, which are not only invaluable, from an administrative point of view, to the Bureau, but also are of great service to other departments of the Government.

As in previous years, the Bureau of Forestry has devoted considerable time to the inspection of private woodlands owners of which desire to have registered. More than 16 per cent of the total area registered during the last 17 years was registered in 1916, the average size of holdings last year being about 1,400 hectares. The registry of such lands with the Bureau of Forestry is required previous to the exploitation of the forest resources, and careful surveys of the property, with detailed data on the timber present, is needed in order to prevent the fraudulent use of public timber on adjacent lands.

Another phase of land work of importance is the examination of public lands, for which application has been made under the homestead laws. A brief glance at the list of enumerated causes for dispute in the approval of applications shows that fraudulent practices in homesteading are common to our Malay subjects as well as to some of the occupants of land in our western National Forests. During 1916 some 7,000 parcels of land were examined. No statement was made as to the number approved.

An encouraging sign is the marked decrease in the number of illegal caiñgins reported over the previous year. The reduction is believed to be due largely to the educational work of the forest officials.

In order to encourage the use of brush lands for caiñgins, authority was granted to clear such land in one district on the condition that the area when abandoned would be reforested with ipil-ipil (*Leucanea glauca*), a tree much in demand for firewood. The results from the first efforts were so successful that there was a large increase in the number of applications from those who were unable to take up homesteads.

Progress was made in the establishment of commercial forests, a policy which has met with great approval from the public in general. Out of a total of 360 such forests in the islands, 22 per cent were established in 1916. The object sought in creating these forests is to provide fuel and timber, especially for communities in regions where some of the public wood supply is remote.

An important phase of forest work in the islands is the reforestation of the land covered with cogon grass (*Imperata exaltata*). Forty per cent of the areas of the islands is covered with cogon, which is useless as a forage, is a fire menace, destroys the productivity of its soil, and also is the breeding places of the vast hordes of locusts which annually do great damage to agricultural crops. The cogon-covered area is gradually increasing, and unless some means of arresting the spread of this grass is found it is doubtful if the locust pest can be controlled.

The Bureau of Forestry has found that the ipil-ipil tree is able to crowd out the cogon grass in two years. In addition to the value of its wood for fuel, the foliage makes a good green manna, the seeds are used as a substitute for coffee, and the root system has marked ability to fix nitrogen in the soil.

The Bureau has taken up the reforestation of cogon lands on a small scale, having a 10,000-peso appropriation for this purpose during 1916. Some 4,000 hectares were reforested on the island of Cebu, largely by broadcasting 24 liters of seed per hectare. Some seedlings were planted on selected spots. The average labor cost of broadcasting was 14 cents (gold) per hectare and for planting $1 (gold) per 1,000 plants. The experiment has proved so satisfactory that the work will be continued in the future.

The lumber industry is reported to be in good condition, having recovered from the serious setback in the early days of the war. The high freight rates on lumber from the Pacific coast of the United States to the Philippines, China, and the Far Eastern countries have to a large extent eliminated competition of Douglas fir with native Philippine species and has made possible the development of a large domestic and export trade. The trade with Hongkong, for instance, trebled during 1916 as compared to 1915, with an increased average value.

The formulation of grading rules for lumber is still under discussion. The rules for Philippine woods adopted by the National Hardwood Lumber Association of the United States are not regarded as practicable, being the same ones used for African and Mexican mahogany, with some slight modifications. So far, local lumbermen have not formulated rules.

One would scarcely look in the report of a tropical Bureau of Forestry for a discussion of "The Fuel Situation," which is of such keen interest to the United States today. Yet during the latter half of 1916 the fuel situation in the islands became acute, due to a marked advance in the price of coal. The United States Army and railroads and factories in some parts of the islands were forced to the use of wood as fuel. An increase of 37 per cent in the wood cut from public forests occurred during the last three months of 1916, with a saving of $4 to $5 (gold) per ton for each ton of coal for which wood was substituted.

Statistical tables in the appendix show a larger lumber cut in 1916 than in any previous year of American occupation, with a corresponding increase in revenue. Timber sales were approximately $250,000 (gold). The expenses of the Bureau of Forestry were 58 per cent of the receipts, as compared to 64 per cent in 1915. Lumber exports for the year were 38,776 cubic meters, valued at $490,644 (gold), and lumber imports 11,766 cubic meters, valued at $159,952 (gold). Exports of gums and resins were valued at $157,031 (gold). The chief lumber exports were to the United States and China; the chief gum and resin exports to the United States. Imports of forest products were very largely from this country.

A report of a forest reconnaissance of Samar Island constitutes a portion of the appendix. This island is south of Luzon and to a large extent is in an unsettled condition, 82 per cent of the area being covered with a commercial forest. The stand per acre in different compartments runs from 17,000 to 43,000 feet per acre over large areas, the prevailing species belonging to the family Dipterocarpaceæ. The report shows that the Bureau continues to maintain the high standards of previous years, even though hampered by a lack of sufficient technical force.

R. C. B.

The Red Spruce: Its Growth and Management. By Louis S. Murphy, Forest Examiner. Bulletin 544. United States Department of Agriculture, Washington, D. C., October 31, 1917.

In common with many Eastern foresters, the reviewer had wondered why the Forest Service apparently neglected its first love—the Eastern spruce. This bulletin makes ample amends for any apparent neglect and fills a long-felt want. Whether or not it fulfills its avowed "chief purpose, . . . to formulate definite systems of forest management for various conditions," is another question.

The bulletin opens with an admirable exposition of the uses of spruce, amount and value cut and imported, present stand, and value of spruce and spruce stumpage.

From this we learn that spruce ranked sixth in 1909 in the amount of lumber produced. In pulp production it ranked first, ninth in slack stave production, twelfth in slack heading production, and ninth in slack hoop production. In 1910, 1,449,912,000 feet of spruce lumber were produced; in 1914, 1,245,614,000 feet, and in 1916, 1,129,750,000 feet. In 1916, 3,143,793 cords of spruce were consumed for pulp, of which 2,399,993 cords were domestic spruce. For lumber and pulp the total production in 1916 was 2,329,747,000 feet, of which lumber was 48 per cent and pulp 52 per cent. In 1909 lumber constituted 63 per cent of the 2,575,172,000 feet produced that year.

The present stand of spruce in the Eastern region is estimated to be 56.3 billion board feet, of which 46.2 per cent is in Maine, 23.6 per cent in New York, 15.3 per cent in West Virginia, and 10.5 per cent in New Hampshire. The average stumpage value of red spruce in 1912, based on estimates, was $6.11 per thousand feet board measure. In the Northeastern States it was $6.50 per thousand feet board measure, New York leading, with a value of $7.25 per thousand feet board measure.

The second part of the bulletin deals with the silvical aspects—range and distribution, forest types, second-growth stands of spruce, soil and moisture requirements, light requirements, windfirmness, reproduction, form, length of life, susceptibility to injury, growth, and stands and yields. This portion of the bulletin is altogether admirable; in fact, it is masterly. For special praise the description of forest types might be singled out. Regarding seed production, the interesting statement is made that the interval between succeeding full seed crops varies from three to seven or eight years, and that spruce produces from 50 to 90 per cent perfect seed, from 60 to 80 per cent of which germinate. The largest quantity and best quality of seed is produced in the virgin forest by trees from 10 to 18 inches in diameter at breast height; full crop production begins about the fiftieth year. The effective range of seed distribution is probably not more than 200 feet.

Speaking of spruce reproduction under hardwoods, the telling point is made that "whether fall germination takes place . . . or not, the seeds, or germinates, will be covered with a thick layer of hardwood leaves. In the spring the warm rains and sun start fermentation of this mulch, and while this at first affords conditions exceedingly favorable to the germination of the spruce seed, the young seedlings are unable to survive the continued heat and humidity and the general smothering effect of the hardwood leaf litter. The trouble thus seems to be not that the seedlings are unable to get their roots into mineral soil or other suitable material, as is usually claimed, but that the heavy mulch prevents them from getting their shoots up into the needed light and air."

In the portion on "Fungous Growth" the author's advice that "merchantable trees in a defective condition, whatever their size, should be removed in order to get the present value of their sound portions and at the same time prevent so far as possible their becoming a menace to the healthy trees remaining" deserves to be heeded more than it is, the New York State Forest Preserve being a case of flagrant disregard of this need for sanitation. Similarly, under "Insects," the author rightly points out that "since the mature living timber is the most subject to attack, the cutting over of the remaining virgin tracts, using an approximate diameter limit of 14 inches at breast height, will greatly reduce the danger of subsequent serious damage arising from this source." The admonition, on page 47, "to improve . . . sanitary conditions by felling and swamping badly defective and dead trees and snags," is also excellent.

In Tables 6 and 13, showing the height and diameter growth, respectively, of Norway spruce, the author requests that the following corrections be made:

TABLE 6.—*Height Growth of Norway Spruce*

Age *Years*	Average height of stand *Feet*
5	2
10	7
15	15
20	27
etc.	etc.

TABLE 13.—*Diameter Growth of Norway Spruce*

Age *Years*	Average diameter breasthigh of stand *Inches*
5	0.0
10	0.3
15	1.5
20	3.7
25	6.0
30	7.2
35	8.2
etc.	etc.

Under the caption "Volume Growth," the author speaks of the fact that "spruce does not respond immediately to an opening up of the crown cover." He neglects to give any definite figures, such as those in the article by Bentley on "Accelerated Growth of Spruce after Cutting in the Adirondacks," in the November number of the JOURNAL. In fact, the author has apparently made little effort to secure recent data from any but the most obvious sources. The latest figures he quotes bear date of 1912. It would be a sad commentary on the unproductiveness of Eastern foresters if nothing worth while had been learned about spruce since that time. It is to be regretted that the bulletin does *not* contain much valuable information about the production of red spruce, which would have been easily available.

The table on page 39 (unnumbered) is an echo of the old Bureau of Forestry Working Plans. This method of determining the volume growth is simple and satisfactory, provided that stress be laid on the need of discounting for mortality and for unthrifty trees. Of greater value are the tables (15 and 16) showing cubic volume growth of red spruce in the Adirondacks and West Virginia respectively. A comparison of the growth in these two regions shows them not to be so dissimilar as we might suppose. Thus:

	Years	D. b. h. *Inches*	Periodic annual growth *Cubic feet*	M. a. i. *Cubic feet*
Adirondacks	70	10	.7	.214
West Virginia	70	10.5	.83	.271
Adirondacks	80	12.0	.8	.288
West Virginia	80	12.5	1.1	.375

It would have made the bulletin more useful if for each region height, volume, and growth per cent had been combined into one table, somewhat as has been worked out for the Adirondacks in the following table:

Height, Volume, and Growth Per Cent of Red Spruce, Spruce-hardwood Type, Adirondacks

[Based on U. S. Dept. of Agriculture Bulletin No. 544]

Diameter breasthigh *Inches*	Height feet (Table 4)	Volume cubic feet (Table 40)	Age, years (Table 10)	No. of years to grow last inch in diameter	C. a. i. per cent Pressler	C. a. i. per cent curved
5......	34	2.8	49.5	....	...	10.6
6......	39	4.4	54.1	4.6	9.7	9.5
7......	43	6.4	58.6	4.5	8.2	8.2
8......	47	8.8	63.1	4.5	7.1	7.1
9......	50	11.6	67.7	4.6	5.9	6.1
10......	53	15.0	72.5	4.8	5.3	5.2
11......	56	18.9	77.6	5.1	4.5	4.4
12......	58	23.3	83.0	5.4	3.9	3.7
13......	60	27.5	89.0	6.0	2.8	3.1
14......	62	33.0	95.7	6.7	2.7	2.6
15......	64	39.0	103.5	7.8	2.1	2.1
16......	66	46.0	112.6	9.1	1.8	1.7
17......	68	52.6	123.4	10.8	1.2	1.3
18......	70	60.0	.....	....	...	.9
19......	71	67.8	.....	....	...	.6
20......	73	76.7	.....	....	...	.3
21......	74	85.4	.....	....	...	....
22......	76	96.2	.....	....	...	....

In Table 17 a column should have been provided giving the mean annual increment (m. a. i.), based on cords, to show at a glance at what age the culmination comes. We supply this as follows:

Mean Annual Increment, in Cords, of Red Spruce in Old-field Stands

[Based on Table 17]

Age (*Years*)	Site I (*Cords*)	Site II (*Cords*)	Site III (*Cords*)
40..................................	.775	.57	.37
45..................................	.88	.68	.49
50..................................	.96	.76	.56
55..................................	1.00	.80	.59
60..................................	1.00	.80	.60
65..................................	.97	.80	.60
70..................................	.97	.77	.59
75..................................	.933	.76	.57

Table 18, showing normal yields for Norway spruce, raises the old question whether our Site II is equivalent to the European Site II or III (cf. recent issues of the JOURNAL). The author apparently considers our II as the European III and our III as the European V, which is open to question, in view of what Zon has pointed out. (See final number of the "Proceedings of the Society of American Foresters," p. 441). The author reaches the interesting conclusion that "lack of management rather than any inherent deficiency in growing qualities was the factor most largely responsible for the less favorable showing of red spruce."

The methods of cutting are good as far as they go, but do not go far enough. In the first place, they should have been definitely correlated with the different types so well described on previous pages. How this may be done is shown in the article by Bryant on "Silviculture at Axton and in the Adirondacks Generally," in the November number of the JOURNAL. In comparison with this article's unequivocal statement (p. 894), that "in general, if the softwoods are logged to a diameter limit on hardwood land, there will be no substantial natural reproduction of the softwoods," the bulletin's advice (p. 47), that "the elimination of the hardwoods need not be carried out so severely," seems feeble.

The author's terminology should be brought up to date. "Shelterwood compartment method" is no longer in good repute. The dissertation on "Clean cutting in strips" is interesting, but will it meet the test of practical logging requirements? Bryant in his article disposes of it with the terse comment: "Some recommend a strip system two tree-lengths wide. This was not regarded as feasible from a logging standpoint" (p. 895).

The chapter on "Improvement cuttings" is interesting, but (what a remark from a professor!) chiefly from an academic standpoint. For example, the assumption (p. 57) that "at the time of removal of the hardwood cover, in the forty-fifth year, the understory of spruce would have a development parallel to that of a 25-year-old stand which had started in the open," runs counter to the hard-headed fact which Bryant records (p. 894), that "softwoods . . . have little or no increment or reproduction, potentially commercial, unless the hardwoods are cut." What a pity the author of a bulletin on red spruce could not have attended this Axton conference of men who think in terms of red spruce as it is and not as it ought to be!

The sections on brush disposal and sowing and planting are excellent. The author gives the following figures for cost of planting with different classes of stock, using a 6 by 6 foot spacing:

2-year-old seedlings	$5.24 per acre
3-year-old transplants	8.63 per acre
4-year-old transplants	10.08 per acre

"Such a stand properly thinned should show a final yield in 45 years of from 32 to 55 cords per acre."

Under rotation, the author recommends 55 to 60 years for pulpwood; 100 to 120 years for sawtimber. No mention is made of financial rotations, nor of the entire subject of financial possibilities. This would seem to be indispensable in a bulletin whose object is "to formulate definite systems of forest management for various conditions"; for is not forest management "the application of forestry in the conduct of the business of a forest?" and what is business but applied finance?

A. B. R.

PERIODICAL LITERATURE

BOTANY AND ZOOLOGY

Distinguishing Characters of North American Sycamore Woods

Four out of five of the known species of sycamore are natives of North America. Brush has recently published a detailed description of the three species which occur within the boundaries of the United States.

Under "Gross structure" is presented a brief description of the sapwood and heartwood, of the annual rings of growth, and of the pith rays. The color of the sapwood and heartwood and the size of the pith rays are pointed out as being the chief gross and distinguishing characters of the sycamore woods. The average weight of the wood and its hardness vary but little in the different species and cannot be depended upon as distinguishing characters.

The writer's study of the minute structure of the wood of the three species appears to show that the pith rays are the only reliable means for identifying the wood of the indigenous species. Viewed in the tangential section, the pith rays are broadest horizontally in the eastern and narrowest in the California species; the rays lowest vertically in the eastern and highest in the California species. The rays of the Arizona species are intermediate in character.

The account of the gross structure and minute anatomy of the wood is followed by an analytical key based on the pith rays. The article closes with an excellent account of the individual characters of each of the native species under the following heads: Distribution, Uses, Gross characters, Vessels, Tracheids, Wood fibers, Wood parenchyma fibers, Intermediate fibers, and Pith rays. The description of the wood of each species is supplemented by drawings and microphotographs.

J. W. T.

Botanical Gazette, Vol. LXIV, December, 1917, pp. 480-496.

SOIL, WATER, AND CLIMATE

Forests and Floods

Mr. Lehman, who was connected with the Ohio Flood Commission, presented before the Forestry Conference at Pittsburgh a paper describing in detail the upper Ohio River basin. We quote from his statements the following:

"In connection with the extensive investigations of the Flood Commission, which had its origin in the Pittsburgh Chamber of Commerce, it was thought advisable to know the extent of the forest cover of the combined basins, and in this regard the United States Forest Service and the Pennsylvania Forestry Department co-operated with very valuable results. Using the forest map provided, as a basis, it was found, in 1912, in totaling the many hundreds of detached areas, that about 7,700 square miles, or, say, 41 per cent of the basin above Pittsburgh, was wooded, the rest of the country being denuded and composed of cultivated and barren land. A very considerable part of the 41 per cent, of course, consists of second and third growth trees of little or no present commercial value. About 360 square miles, or 2 per cent of the basin, remains in virgin forest, the greater portion being situated on the higher elevations of the northeast parts of the basin. Most of the good timber is now found above an elevation of 1,500 feet above sea.

"Judging from indications obtaining at the time of the investigations, over 400 square miles of timber were destroyed by fire, involving some of the virgin timber.

"The tree types are distributed in general as follows: White pine, in the northeastern part of the Allegheny; hemlock, mixed oaks, and chestnuts, scattered over the combined basin; also beech, birch, maple, and basswood, but these largely on the high elevations.

"Incidentally an estimate is ventured of the quantity of virgin timber cut from the combined basin. Under the assumption that about 14,000 square miles, or 70 per cent, were in commercial growth, and that there were only 12,000 board measure produced to the acre, the amount would reach nearly 168 billion feet for the first cutting alone. If only half of the present stand, say 3,800 square miles, were properly treated, a yearly asset of considerable proportions for all interests can be calculated.

"As to floods, it was found that from 1872 to the end of 1911 there were 53 floods that reached heights above the danger stage at Pittsburgh, which is 22 feet above zero at the gage. The flood of March 15, 1907, reached a height of 35½ feet. Dividing the time, 1872 to 1912, into five-year periods, it was seen that there was an increase in the frequency and height of floods, as indicated by the following:

1st period	2
2d period	3
3d period	6
4th period	8
5th period	7
6th period	5
7th period	11
8th period	11
Total	53

"The mean annual precipitation over the Allegheny slightly exceeds 42 inches, while over the Monongahela it is 45½ inches. In the former, in the northern section, the maximum reached, to 1912, was about 60 inches, and in the latter, southern section, nearly 81 inches. The records of the many stations do not disclose any material change, at least in the amount of annual precipitation.

"The maximum discharge of the Allegheny, at the mouth, has been estimated at about 300,000 second feet and the minimum over 900. The Monongahela maximum, 41 miles above the mouth, 207,000 second feet falling to about 160 for the minimum. The flood wave of 1907, which remained above the danger line, 22 feet, about 61 hours, discharged a total of about 76 billion cubic feet; the volume above the danger line amounted to nearly 26 billion cubic feet. This serves to indicate, in a manner, the stupendous amount of water that goes to waste annually.

"As to the causes of the floods, it is evident that they are chiefly due to heavy concentrated precipitation, but deforestation must have influence in the frequency and height."

The Upper Ohio River Drainage Basin. Forest Leaves, October, 1917, pp. 66–68.

SILVICULTURE, PROTECTION, AND EXTENSION

Agency of Fire in Propagation of Longleaf Pines

Andrews has recently reported a field study on the effect of fire on the natural regeneration of longleaf pine in northern Georgia near the extreme inland and upland limit of its range. The author calls attention to the recognition by other writers of the part played by fire in longleaf-pine reproduction and then goes on to describe his own observations in considerable detail. He states that he "has recently been favored with exceptional opportunities for investigating this subject by means of an experiment carried on by Nature herself in the native home of the longleaf, with all the exactness of detail that could be expected in a well ordered laboratory."

Many of the southern slopes in the region studied are covered with the remains of great forests of longleaf pine interspersed with scrub and shortleaf pines and numerous hardwoods. They have been repeatedly cut for lumber and have been frequently burned over by ground fires. The author states that the longleaf pine continues to reproduce itself on these slopes with a pertinacity which will in the course of a generation or two, if not interfered with, repopulate them with a new forest growth sprung from the old stock.

There are few traces of longleaf-pine forests on the northern slopes, although there are traditions of their former presence there. The writer finds the "natural experiment" alluded to in two small isolated groups of longleaf pine on northern slopes on opposite sides of a ravine. The first of these groups contained five longleaf-pine trees scattered over an area of approximately one-half acre, which had been repeatedly cut over and cleared of undergrowth by repeated minor fires. One of these individuals was a large, rugged patriarch. Aside from the five specimens mentioned, there were no other longleaf-pine trees in the group noticeable above the coarse grass, although at the time (July, 1913) no attempt was made to determine the presence of seedlings.

The second group, separated from the former by a ravine and the woody crown of a knoll, when first observed contained four longleaf-pine trees, three of which had attained full cone-bearing age, the larger being about six feet in girth. But one seedling was observed. The soil in both situations was the same and the ground cover of Pteris, Tephrosia, and coarse grass was strikingly similar.

The two groups were again visited in July, 1915, prior to which a fire had occurred in and near the first group, particularly over a cultivated adjacent field, which had grown up to weeds mixed with a scrub growth of bush and brambles. The fire exposed a thriving colony of young longleaf pine over the formerly cultivated field. Although the seed trees stood on the border between the field and the copsewood, reproduction was confined to the old field. The longleaf-pine seedlings had, without a single exception, withstood the fire, while the weeds were killed.

The writer contends that the pine seedlings, save the strongest among them, would have perished but for the timely interference of their powerful ally, the fire, which swept away all rivals and left the pines in undisputed possession of the soil.

On the other side of the ravine the other group had not experienced a fire and the single seedling found at the time of the first visit was again found with difficulty.

In the reviewer's opinion, the writer has drawn his conclusions from the comparison of two sites where the conditions for natural reproduction were entirely unlike. In the first group reproduction is confined to a formerly cultivated field. The burning revealed seedlings already there. There were no abandoned cultivated fields similarly situated in reference to the second group, and the inference is there were no seedlings to be revealed had a fire occurred.

The article presents no convincing proof that fire made the reproduction on the abandoned field possible, but rather that the seedlings that started there were able to survive the fire. Their presence there and not elsewhere was most likely due to changed soil and cover conditions, due to former cultivation and not to fire. There is no proof presented that they would not have survived on the formerly plowed area, even if the fire had not occurred.

Many studies elsewhere in the South indicate that the reproduction of longleaf pine is not made possible by ground fires and brush fires, but rather that the species is wonderfully adapted, even in its juvenile stage, to survive them. In most places in the South the pasturage of hogs in longleaf-pine forests is a decided factor in reproduction.

J. W. T.

Botanical Gazette, Vol. LXIV, December, 1917, pp. 497–508.

Hail Damage

Damage by hail to forest growth is rare and usually insignificant. Badoux recalls some cases in which the damage was sufficient to require the cutting of the injured stands to avoid insect pests, notably some 600 acres of pine and spruce of all age classes in 1888 in Silesia and some 300 acres of 50 to 120 year old stands of the same species in upper Bavaria in 1900. Some 30,000 acres in Switzerland and Baden were more or less damaged in July, 1881, when in broadleaf stands the foliage turned yellow and brown, the coniferous stands looked as if caterpillars had eaten them, shoots and 1 to 5 year branchlets with leaves and needles covered the ground completely and the bark was often broken. It does not seem, however, to have been necessary to cut prematurely anywhere, but the repair of the damage was rather slow and staghead and death of trees was not infrequent.

More detail of the damage is given by the author regarding an unusually severe hail storm that took place in Switzerland in July, 1913, at an elevation of over 3,000 feet. The hail stones reached the size of hens' eggs, and in some places were piled 20 inches high, after 24 hours measuring still 12 inches along a house wall. In the forest the ground was covered with leaves and twigs. The spruces, the dominant species, were entirely defoliated on the windward (western) side, the leeward side remaining comparatively little damaged. Two years later the aspect remained still the same; in the years 1915 and 1916 a large part of the trees had become stagheaded, but only a small number of spruce had died. Being accustomed to the ills of an alpine climate with stout, close foliage, the spruce originating from natural regeneration is evidently more resistant than it would be under other conditions.

The author attempted to determine the degree of damage in a small 55-year-old spruce forest by use of the increment borer on seven more or less damaged dominant trees and some check trees. The diameter increment of the injured trees in 1914 had suddenly fallen to less than half that of 1913, namely, from 4 cm. to 1.9 cm., while the check trees had fallen from 4.1 cm. to 3.3 cm. The volume increment, then, was only 25 per cent of that of 1913. In single trees greater differences were found, namely, down to 4 per cent of the previous year.

Durch Hagelschlag verursachter Zuwachsverlust in einem Fichtenstangenholz. Schweizerische Zeitschrift für Forstwesen, December, 1917, pp. 329–333.

Forestry in the Adirondacks

Samuel N. Spring, in a most readable article, tells of the historic "Axton Conference," August 31, 1917, reported in the November number (pp. 891-895). He tells how the trip came to be made and how "Dr. Fernow was the center of the group all day, happy as a boy on vacation and eager to see his handiwork after the lapse of fifteen or more years."

Touching on the Adirondack forestry problem, the author says: "The problem was the management of a decadent hardwood forest from which the softwoods had already been logged. For the logging areas the treatment was, in the Doctor's own words: 'Removal of the hardwoods except thrifty young growth, preferably in groups, burning brush (from tops), and planting with conifers, especially white pine and Norway spruce.'

"Follow the party into a typical logging area so treated. Passing through a strip of timber by the road, Dr. Fernow led the way into a young forest showing no traces of logging, containing a fine growth of planted pines and spruces mingled with hardwoods that have seeded into the stand naturally. The future value and the present value cannot be questioned. Pine and spruce are alike at home and vigorous in growth; the soil is protected and the full usefulness of this forest land assured. In contrast one need only to view land cut over and burned in the Adirondacks or to see an experiment across the road, where the timber was logged, the brush burned, and the rest left to nature. There the stand is open and inadequate, the species generally inferior."

He ends with the interesting observation that of the various species planted "European larch overtopped all. . . . Species from the West, planted experimentally, interested the foresters greatly, but the species deserving the blue ribbon were our native white pine and the introduced Scotch pine and Norway spruce."

A. B. R.

Seeing Forestry Work in the Adirondacks. Lumber World Review, November 10, 1917.

UTILIZATION, MARKET, AND TECHNOLOGY

Value of Douglas Fir

In a well-illustrated article Samuel J. Record discusses the use of Douglas fir for structural purposes. He speaks of the two distinct forms of the tree which are recognized, namely, the Rocky Mountain form and the Pacific Coast form:

"They would be considered distinct species did they not in portions of their range intergrade and lose their identity. Even the coast form of Douglas fir is not uniform in quality, and lumbermen recognize two kinds, known as red fir and yellow fir. In the denser stands the trees grow rapidly in height, but slowly in diameter, and the fine-grained, light, yellowish wood which results is the so-called yellow fir. Where the stands are more open and the trees can get more light the increase in diameter is correspondingly greater and the wider annual rings are reddish in color and exhibit more contrast between the soft open spring wood and the dense flinty material produced later in the season; this is the red fir of the lumberman. That the difference is mainly due to rate of growth is attested by the fact that the same tree may produce the red or coarse grade of material in early life, when diameter growth is rapid, and the yellow or fine grade later, when the annual rings become narrower, as they do in old trees. Thus a log may yield yellow fir from the outside and red fir from the interior. The mountain form does not exhibit this difference, and even the fine-grained wood is red and hard."

Speaking of available supplies of Douglas fir, an estimate of 500 billion board feet is made, and the statement that "there is enough of the coast form to supply the demands for an untold number of years to come. Certainly this generation will not see any scarcity of it, though the waste in logging and through fire is excessive."

A. B. R.

Douglas Fir. The American Architect, Vol. CXII, No. 2185, November 7, 1917, pp. 329-333.

Future of Spruce in Sweden

Prof. Gustav Lundberg, of the Swedish College of Forestry, in a lecture delivered before the Paper and Cellulose Engineers' Association on February 17, 1917, made the following illuminating observations regarding the place of spruce in Swedish forestry:

"For the pulp industry, the same as for all other wood-consuming industries, times are coming when the competition for the raw material will be a question of life and death, or, to some mills, to be or not to be. But in order to be able in due time to estimate these conditions and as a result face them with more ease, no doubt it ought to be in the interest of this Association to agitate for the intended State inventory of Sweden's forests to be made at once. And in the planning of this inventory, the representatives of the pulp industry surely have some interests to guard. For instance, that the results of estimates are summed up for properly restricted districts of consumption, that such trees are specified which can serve as raw material to the pulp industry, etc.

"And of all the measures which bear upon the future there is hardly one more important than that spruce, the specialty of the pulp industry, in the provision for regrowth of our woods will get the proper attention it deserves. As it is only very lately that spruce has reached the same value as pine, the impression commonly prevails that spruce must needs be of less value than pine.

"When a woods is clear cut, only seed trees of pine are left, because spruce trees will blow down or dry out if left standing free, and when sowing mixed spruce and pine, which is mostly the practice, it will be the pine, growing rapidly in its youth, that will be the dominating tree. In other words, the pine has many possibilities at present to be favored at the cost of the spruce. And nevertheless there can be no doubt that the spruce, even on account of the cellulose industry, is the tree of the future, which will be of the highest value. When, in addition, spruce on the better soil gives quantitatively greater production than pine, it is time now to restrict the cultivation of pine to the proper pine grounds; that is, such soil where the spruce does not attain its full development."

The author also warns of the approval of a critical period "when the wood-felling cannot be continued at the present rate," and advises his hearers to "undertake at once all the measures which might better answer the demands of the mills for raw materials."

A. B. R.

Svensk Pappers Tidning, Stockholm, February 15 and 28, 1917, pp. 28 and 34 respectively.

Alcohol from Sulphite Liquor

The prevailing high prices for alcohol have served to direct a great deal of attention to the practicability of utilizing waste sulphite liquor from pulp mills in the production of ethyl alcohol. An article by Dr. Erik Haegglung, technical director of the sulphite alcohol plant at Bergvik, Sweden, giving details of methods and processes involved in such utilization, has recently been translated from the German by O. F. Bryant, of the Forest Products Laboratory of Canada. According to Haegglund, the real source of the fermentable sugar in the waste liquors is rather obscure. At the most, 1 per cent of the cellulose of the wood is possibly converted into sugar, and there is some doubt whether any cellulose is actually converted into sugar. Yet under favorable conditions the fermentable sugars in waste liquors amount to 14 per cent. Investigations have indicated quite plainly that this sugar does not come from the cellulose portion of the wood, but very probably from the carbohydrates of the spruce wood that are soluble in water. Waste sulphite liquor cannot be directly fermented, due to the presence of sulphurous acid and such organic acids as acetic acid and formic acid, and these must first be neutralized. This is accomplished by first aërating the liquor with compressed air to oxidize the sulphurous acid and other reducing substances, and at the same time adding the neutralizing agent, which is usually freshly slaked lime. Pulverized limestone is finally added to insure complete neutralization, and the liquor after settling is drawn off into tanks, where it is cooled and distributed to the fermenting vats. Quicklime cannot be used in neutralization, as the momentary alkalinity produced around each particle of lime as it becomes wetted with liquor breaks up the fermentable sugars. The neutralized liquor is fermented in large vats with special resistant yeast. The yield of alcohol obtained is very much influenced by the kind and quality of the yeast. Waste sulphite liquor contains an insufficient quantity of nutriment for the yeast, and special mixtures to supply the necessary phosphates and nitrogen must be added to the liquor in building up the cultures of yeast. The fermented mash is distilled in column stills, and an alcohol with a strength of 96 per cent by volume can be directly obtained. This alcohol is, however, quite impure, containing as much as 3 per cent of methyl alcohol, with lesser quantities of aldehyde and fusel oil. The aldehyde and fusel oil are readily removed by redistillation, and recent improvements in distillation methods render possible the removal of the methyl alcohol through controlled distillation. The effect of the dealcoholized mash, or waste liquor, upon fish in streams is as yet a moot question, though it is certain that it is much less damaging than the ordinary waste sulphite liquors. The cost of production of alcohol from waste liquor, including interest and amortization, is given as approximately 10 cents per United States gallon.

B. L. G.

Waste Sulphite Liquor and its Conversion into Alcohol. Pulp and Paper Magazine of Canada, December 6, 1917, pp. 1125–1129; December 13, 1917, pp. 1157–1164; December 20, 1917, pp. 1185–1192.

STATISTICS AND HISTORY

Timber Trade of Australia

Acording to H. R. MacMillen, Australia up to the present has furnished the most important overseas market for the forest products of the Douglas-fir region. The total lumber exported from the North Pacific coast to Australia from 1894 to 1915, inclusive, was 2,230,000,000 feet, most of which was Douglas fir. Since Australia is now on the threshold of an extensive industrial and agricultural development, this consumption of Douglas fir may well be expected to increase steadily.

There are 1,072 sawmills in Australia and Tasmania, which in 1913 produced 683 million feet of lumber, which amount comprised a little over half of the total consumption of lumber for the year. The forests of Australia are comparatively small in extent, and unless assisted by importations would supply the domestic demands for only about twenty years. The forests also are almost wholly composed of mixed hardwoods, belonging chiefly to the eucalyptus, gum, acacia, and locust families. While many of these species provide timber which is unexcelled for railway sleepers, wharves, piling, paving, and industrial uses where great strength, hardness, and durability are required, they are not suitable for general building and structural purposes. The factors which limit the use of the native timbers are the great weight, the tendency to warp and check seriously, the difficulty of working the wood, the inefficient methods of logging and manufacturing, and the cost of these operations, which in normal times is so great that Douglas fir and Baltic spruce sell for less than the native woods.

The average annual consumption of manufactured timber per capita is 196 feet board measure, which is not as great as might be expected in a new country in process of development. This is due to the fact that two-fifths of the population live in cities, and urban population does not require the same proportionate number of buildings as an agricultural population; also there is a predisposition to build houses, both in the city and country, of brick or stone rather than wood, and to use tile or galvanized-iron roofs instead of shingles.

There has been great lack of co-operation on the part of manufacturers of Douglas fir in the Australian market. The product is largely handled by about ten shipping companies, who, due to their methods of buying from the producer, have created a state of competition unknown in other manufacturing industries of like importance. Thus fluctuation in prices for a single month are often considerable, and lumber is often shipped which is better than the specified grade, which has resulted in the market demanding high grades where poorer grades would serve the purpose as well.

Generally speaking, the prospects for the further exportation of Pacific Coast woods in Australia are very good, but the extent of their success will to a large measure depend on the attitude of the mill owners. Among the fundamental things necessary for success are a co-operative organization of manufacturers to develop the trade, educational and advertising campaigns as to the worth of the American woods, uniform grade rules and price lists which will be lived up to, and permanent transportation lines between the lumber centers of the Pacific Coast and the consuming centers of Australia.

The Timberman, May, 1917, p. 36; June, 1917, p. 33; August, 1917, p. 35.

Finnish Forests

The Bureau of Forestry of Finland has recently issued its annual report, containing statistics obtained in 1913. According to this report, the government forests include an area of 31,068,773 acres, or approximately 33 per cent of the land area of Finland. This area is classified as follows: Cultivated lands, 177,682 acres; forested areas, 13,166,888 acres; water, 1,184,802 acres; bog and swamp land, 16,539,401 acres. During 1913 forest fires occurred on an area of 5,405 acres, causing an average damage of $7.32 per acre. Receipts from forest products during 1913 amounted to $3,034,533, while the disbursements reached a total of $1,104,599, leaving a net income of $1,929,934. The supervising force in charge of the government forests is composed of 10 senior foresters, 100 foresters, 100 to 150 assistant foresters, and about 1,000 labor foremen and forest guards.

B. L. G.

Skogsvardsforeningens Tidskrift, July–August, 1917, pp. 715–717.

EDITORIAL COMMENT

Further Developments in the Airplane Spruce Situation

In the December, 1917, issue it was stated that spruce production (which amounted in 1909[1] to only 225 million feet of all lumber grades in Washington and Oregon, and which has apparently never exceeded 300 million feet board measure, only 10 to 15 per cent of which would grade as airplane stock) could not be brought up to military requirements without aid from the Government. Shortly after the former statement was written, an investigation of the situation by Col. Brice Disque, of the Signal Corps Aviation Section, brought the situation forcibly to the attention of the War Department. With commendable promptness that Department created the spruce-production division in the Signal Corps and placed Colonel Disque in charge, with full authority to supervise and secure spruce production by any necessary means. Vigorous measures have followed, which give promise of increasing the production of spruce to the required amounts (10 million feet board measure or more per month) within a short space of time.

The measures taken include the formation of a military force of sufficient size to bring the number of men working in the spruce region from some 3,000 up to 10,000. The first efforts will be toward bringing existing producing operations to maximum production by furnishing military units where necessary to supplement present labor supply. An ingenious method has been devised through which employers will not obtain labor from this source any cheaper, and soldiers who have volunteered for the service will receive the same wage as civilian employees. The management is thus fair both to the existing labor, the employer, the soldiers, and the Government. It is wise in utilizing established organizations and bringing in new only where necessary.

Logging and sawmill operations along the usual lines will be supplemented by riving spruce in stands which cannot be reached at once by extension of logging operations. Riven spruce can be taken out over ordinary highways, so the amount of stumpage immediately available is enormously multiplied. Adequate measures have been taken to transport this material with motor trucks.

These points and others were brought out at recent meetings with

[1] See Table 1, Bulletin 544, U. S. Department of Agriculture.

Washington and Oregon lumbermen. At these meetings Colonel Disque frankly explained the situation and obtained promise of hearty co-operation on the part of lumbermen, it is said, representing 75 to 90 per cent of the local lumber industry. This summarizes the present situation, which has been changed by efficient organization from gloom to optimism, although the realization remains that no stone must be left unturned if success is to result.

In the December issue we advocated measures at an early date leading to taking over the spruce forests by the Government in order to conserve this important material. The limited supply is badly scattered and any measures taken by the Government can be expected to secure only the largest stands. These stands can be extended by silvicultural measures to produce all needed future supplies. It seems evident that so far as Germany uses spruce in airplane construction it has been produced under forest management on her own soil. Little of the spruce region is within the National Forests, and one of the most obvious measures seems to be to return the entire fog-belt area west of the Olympic National Forest to Government ownership, to be worked in such manner as to conserve the spruce not needed for immediate consumption and by silvicultural measures extend the stands to occupy suitable areas which are wide in extent. Of course, substitutes may be developed, but it would be folly to act on that assumption. So far spruce seems to be clearly superior, and we have been told by experienced men that failure of metal parts in airplanes under ordinary conditions is far more common than failure of the wood parts.

A Serious Situation in the Lumber Supply

The current lumber journals are making dire predictions, on the prospects of the lumber production of the year. The unprecedented demands created by the military situation have caused what is already beginning to be a serious situation in the lumber supply, and this situation promises to become more serious during 1918. In the New York *Lumber Trade Journal* for December 1, 1917, it is pointed out that the increased demands for lumber, coupled with the depleted labor supply, makes it probable that the output of lumber for 1918 will fall to 50 or 60 per cent of the normal. This will, of course, cause a radical readjustment in the selling prices for next year's supply.

The shortage in white pine can be traced directly to the labor supply. Men and boats to handle the lumber at lake ports are not to be had, and it has been impossible in many cases to get more than 50 per cent of the men required for mill operation. The woods crews are also so short that it is estimated the production will be not more than 60 per cent of the normal. The demand for boxes and crates on the part of the Government for shipment of materials and supplies to Europe will require all the available lumber, even of the better grades. Consequently prices will continue to rise higher.

The demand for yellow pine has continued strong and prices will undoubtedly increase. However, the output of yellow pine is expected more nearly to meet the requirements than is the case with white pine. Many companies are practicing economies and making experiments in closer utilization, so that at the close of the war we should be in a better position to take advantage of the lessons learned during the present shortage.

J. B.

NOTES

Second-growth White Pine as Related to the Former Uses of the Land

In connection with the discussion of reproduction in the southern pineries as being favored by previous pasturage of the land, this note (preliminary to a more extended paper) on the history of the second growth of white pine in New England may be to the point.

In the last fifteen years certainly 80 per cent of the cut from this region has come from stands 50 to 100 per cent pure—so-called pine woodlots. Even to a person unfamiliar with local economic history, the geometric, sharply defined shapes of these tracts, discernible by their dark color in any stretch of landscape, suggests the previous uses of the sites. In three townships in the best of the white-pine belt 90 per cent of the pine woodlots originated on land formerly farmed or pastured, and observations in many other towns between the Connecticut border and central New Hampshire indicate that this percentage applies to the whole region. Only under exceptional conditions, such as very sandy soil or the effects of a timely fire, has pure pine survived to maturity on other than cleared land.

The silvical evidence on this point is very neatly corroborated by the historic. The bulk of the merchantable stands are (or have been) from 50 to 70 years old. In the reproduction period thus indicated came the Civil War, the western emigration, and the big development of railroads and manufacturing along the main streams, all of which factors brought about an abandonment of farms in upland townships amounting in many cases to 50 per cent of the cleared area. A knowledge of the history of very many specific cases indicates that pure pine today invariably means pasture or field as the previous condition of the land.

Not all such areas, however, have reproduced to white pine, even though they furnish, as a rule, the most favorable kind of seed bed. It is plain that most of the pine woodlots represent mainly a single fall of seed, since all are nearly even-aged. It is also apparent that several plentiful seed years may occur with no result, in which case the development of woody plants or tough ground cover may preclude pine altogether. The successful combination of factors seems to have been, first, the weak sod or scanty weed growth of land recently grazed or cropped; second, the prompt fall of sufficient viable seed, such as is produced by large, full-crowned trees, and, third, a fair amount of rainfall during the first half of the first growing season.

In drawing conclusions from the life history of these pine woodlots, it is usually overlooked that the existing stands give no hint of the number that failed to materialize through unfavorable influences. Natural reproduction as managed by Nature is excessively costly in seed, time, and wasted area. Nevertheless, in the hands of an experienced man, with adequate local knowledge of soils and vegetation, properly regulated, grazing should go a long way toward controlling some of the factors essential to the reproduction of white pine.

R. T. F.

Girdling Forest Trees with a Gasoline Torch

The fact that a common gasoline blow-torch has been successfully used in girdling trees leads to the conclusion that such an apparatus may be of value in timber-sale operations. At Plainville, Ohio (1908), where the torch was used to girdle such species as willow, locust, maple, and hackberry, the operation was more successful than girdling trees of the same size and species with an ax. Those girdled were all thin-barked species, ranging in diameter from 4 to 8 inches. The trees girdled in late September made an effort to leaf out the following spring, but succumbed entirely by the end of July. Those girdled with an ax, but without removing the chip, remained living for a year, and two of the trees (hackberry) successfully healed the wound in one or two places.

It seems that a torch of larger dimensions than that ordinarily found on the market, or a special apparatus with supply tank slung on the back with the burner attached to a flexible tube, could be designed to meet the requirements of work in the woods. The operation could be hastened by employing a semicircular burner, so that the flame may be applied over a greater surface from one position. It is doubtful if this method could be used in girdling thick-barked species of the older age classes, such as yellow pine, larch, and Douglas fir; but it should be possible to successfully girdle grand fir, hemlock, and other thin-barked species of any age class. As a labor-saving device, it is believed the method has considerable merit and should be experimentally demonstrated on a large scale.

James R. Weir.

Interception or Absorption?

Barrington Moore's article entitled "Factors Influencing Reproduction of Red Spruce, Balsam Fir, and White Pine," in the November issue of the Journal, has been read with interest and profit.

Moore's conclusions concerning the interception of precipitation by spruce crowns seem not to be fully supported, since they are based entirely upon the percentage of moisture found in the soil under spruce crowns rather than on the quantity of water actually received by such areas. It is, of course, patent that a considerable amount of precipitation may be intercepted by a dense spruce crown. That the quantity of water so intercepted is sufficient to almost preclude the growth of vegetation on such areas does not appear to be established, because by such a process the spruce would be cutting off its own water supply as well as that of its competitors.

Moore notes that the root system of the spruce "forms a dense mat in the raw humus or duff—a mat so dense that hardly a square centimeter under a spruce stand escapes." He also states that "spruce is in a position to get the first water that reaches the forest floor."

Does it not seem probable that the disposition of the root system rather than the interception of precipitation by the crowns is the prime factor in bringing about a xerophytic condition under the spruce?

Howard R. Flint.

Empire State Forest Products Association

The annual meeting of the Empire State Forest Products Association, held at Utica, N. Y., on November 8, was characterized by the co-ordinated presentation of the most important problems affecting private forestry practice. The program reflects this intended drive on taxation, fire protection, and reforestation. It is significant to note that not less than twenty professional foresters attended the meeting.

Professor Hosmer opened with an address on "Forest Taxation," which was followed by W. R. Brown's paper on "Standing Timber Insurance." Both of these papers engendered much helpful discussion. In the afternoon Prof. J. W. Toumey gave an admirable talk on "The Economic Aspect of Reforestation in Northeastern United States" and Ellwood Wilson spoke on "Lessons from Canada," with particular reference to the work of the Laurentide Paper Company in reforestation.

The feature of the banquet was the address by President John G. Agar, of the Association for the Protection of the Adirondacks, on "The State Policy of Land Purchase for the Forest Preserve."

West Coast Lumber Manufacturers' Association Meeting

The *West Coast Lumberman* of February 1, 1918, contains an exhaustive report of the meeting of this association on January 26. The annual report of the retiring president, A. L. Paine, besides giving general information as to the activities of the association, contains a striking statement showing that the burdens of association work fall on a few of the more progressive men. In Paine's words: "Did it ever occur to you that the most active men of this association are the ones best able to stand alone?"

Addresses before the meeting were also made by Dr. H. K. Benson, of the University of Washington, who summarized the situation in regard to utilization of mill refuse; H. H. Isherwood, a prominent eastern retailer, urged the necessity of more lumber advertising and backing up the retailer by the manufacturers. Particularly he pointed out the desirability of furnishing the retailer with complete plans and specifications for buildings and parts of buildings, so that the retailer can quote lump-sum bids on requirements of consumers instead of quoting by the thousand feet only.

One of the most enlightening addresses was made by O. B. Harriman, of the Bridal Veil Lumber Company, who elaborated a complete plan for formation of a $1,000,000 corporation termed the Lumbermen's Clearing House, whose function shall be the discounting of lumber invoices for manufacturers and wholesalers and the guaranteeing and collecting of all accounts received for discount, such accounts to be only those of approved credit risks. In support of this plan analytical data are submitted covering 1,000 cars of lumber shipped as follows:

Cars Discounted.—Fifty-nine per cent took 2 per cent discount in 23 days; 17 per cent took 2 per cent discount in 51 days; total per cent, 76; average discount time, 30 days.

Cars Not Discounted.—Ten per cent paid in 65 days; 14 per cent paid in 114 days; total per cent 24; average time, 94 days.

From these and other data, it is shown that three times the capital is required for this purpose by the present methods as would be required under the proposed method of discount by Lumbermen's Clearing House within fifteen days from date of invoice. The proposed method is claimed to have the following advantages:

1. Mills would get sufficient capital to finance shipments without use of bank credits.
2. Terms of payment would be enforced without loss of friendship of customer by individual mill.

3. Enforcement of terms of payment would reduce capital required by lumber industry of Washington and Oregon by 50 per cent.
4. Credit information cheaply obtained.
5. Trade acceptances used where discounts not granted.

This proposed plan is too comprehensive to permit giving adequate idea of it in a short review. If realized, however, it will be an important step in organizing the credit of lumbermen so as to insure cheaper short-term credit. Similar methods applied to long-term requirements would be a step toward obtaining the lower interest rates necessary before any effective steps can be taken toward management of private forests for continuous production.

The Philadelphia *Record* had the following striking and timely editorial in its issue of December 1, 1917:

"THE NEED OF MORE POWER

"No fanciful statistics are required to prove how very much better off the Nation would be if its 'white coal' were now available for the development of mechanical energy. It matters not whether our unused water powers are capable of producing 50,000,000 or 100,000,000 horsepower, or whether hydro-electric power, with the cost of transmission from point of production to point of utilization added, is cheaper by half or twice as dear as steam power converted into electricity or used directly. The fact is that our unused water powers are running unproductively to waste and they cannot be harnessed in time to relieve the existing congestion in the production and distribution of ordinary black coal.

"Crying over spilt milk is proverbially futile; and it would serve no good purpose to revert to the long-drawn-out wrangle about the respective authority of the Federal and State governments over water powers. Nor need one conjure up again the spectre of a water-power monopoly, which former President Roosevelt and Forester Pinchot employed so successfully to render development impossible. It is not necessary for the Federal Government to impose a tax on the use of waters which it does not own, and which the United States Supreme Court declared belong to the States, in order to assert regulative jurisdiction over water powers. Hydro-electric power is an instrumentality of commerce, and, as such, the regulation of the same would come under the jurisdiction of Congress as completely as railroads, telegraphs, or pipe lines, even though this instrumentality should be, as the railroads, telegraphs, etc., are, partly employed in commerce within a State.

"A wrongful use of the Federal taxing power, therefore, is not necessary to bring water powers under legitimately exerted Federal control. The Interstate Commerce Commission makes rates which affect transportation on railroads, even which begin and terminate wholly within a State, and it would be impossible for a water-power company to sell electricity within a State at a higher rate competitively with another company that would be prepared to supply it from beyond a near-by State boundary. As for the creation of a monopoly, the Federal Government could suppress a power trust as readily as it could suppress an oil, paper, tobacco, or any other kind of a trust, even to the extent of confiscating its property. Congress should pass immediately the bill proposed by Secretary Lane more than two years ago and thus make a vast store of energy available as soon as possible. We shall need every ounce of power which our 'white coal' is capable of developing. The emergency may be even greater, after the war reopens international competition, than it now is."

Forestry and Paper Making

On both sides of the line the contention of the newsprint paper manufacturers and of the newspaper associations regarding cost of the manufacture and price of newsprint has been going on for a long time without any result at present writing. In the United States the case is before the Federal Trade Commission; in Canada before a special commissioner. There is one point in the controversy which is of special interest to foresters and which has not received as much attention as it deserves in the testimony on either side. It is the question of supplies of raw material, which should influence the price-making if the law of supply and demand is still to rule. It must not be overlooked that the length of time for which pulpwood supplies can be secured for a mill has a most important influence on the price which it is proper for a manufacturer to charge who must foresee the need of amortization or sinking fund for his plant if he is forced to go out of business for lack of supplies.

If, as appears from the findings of the Trade Commission, the capital required per ton of paper is from $25,000 to $35,000—according to others nearer $50,000—there must be enough in the manufacturers' profit to retire this capital before the end of the supplies to run the mill, or nearly so. There seems to be little doubt that accessible pulpwood supplies in the Northeastern States and even in Canada are becoming scanty and hence more valuable (see evidence published in *Forestry Quarterly*, Vol. XIV, pp. 770 ff.).

In this connection the question of what can be expected from the cut-over pulpwood lands regarding a second cut, regarding reproduction and regarding growth, is of interest. Answer to this question can, of course, come only from a more or less detailed investigation. Such an investigation has been started by the Canadian Commission of Conservation, and a preliminary report of the first season's work was given at the annual meeting of the commission by Dr. C. D. Howe, in charge of the investigation. During the summer of 1917 Dr. Howe examined in a most painstaking manner, by careful analysis of sample areas, woods which had been cut over by the Laurentide Company on their limits in Quebec. While Dr. Howe is careful not to generalize too far from the limited basis of facts ascertained, we do not see any reason why in general terms his findings would not apply to the thousands of square miles of similar type woods that have been or will be subjected to similar treatment in Quebec and Ontario, the great sources of pulp-wood supplies.

In the first place, Dr. Howe finds that in the mixed stands of hardwoods and conifers, which are the rule, balsam fir leads, with 36 per cent; yellow birch comes next, with 26 per cent, and red spruce, with only 20 per cent, the balance being minor species. The determination of the upland spruce, practically all, as *Picca rubra* comes rather as a surprise, extending, as it does, the field of this Adirondack and Maritime province species farther west and north than it had been credited.

The preponderance of the balsam fir, which in general had been known before, is of significance both from the present supply point of view and that of reproduction. As long as water transportation must be relied upon, a considerable loss from sinkers must be expected from fir; besides, considerable damage by rot makes this material less valuable.

The white pine, which formerly overtowered the mixed woods and gave to them a decidedly coniferous character, is almost entirely eradicated, even down to the young specimens and regeneration, except on borders of lakes, swamps, and other open places. Growth studies on some 2,000 trees and countings on many sample areas to determine the character of the stand per acre were made.

In the address before the commission, Dr. Howe most clearly and simply, for the comprehension of the veriest layman, traces the changes that take place as a sequence to the cutting of the pulpwood and what growth to expect.

As regards the diameter increment, the 4 to 8 inch poles were found to be 80 to 100 years old, the 8 to 12 inch class 100 to 150 years; so that it would take at least 50 years for the latter and 70 years for the former to grow into the 12-inch minimum diameter for spruce in Quebec—not an inviting outlook for private enterprise!

Of the 635 seedlings of spruce found on the average per acre, the mortality rate was determined such as to reduce them to six when near commercial size, and the percentage of loss is still greater in balsam.

The growth of the spruce is so slow beneath the overtopping hardwoods, and there are so few survivors per acre in the intense struggle for existence, that the future is hopeless from the standpoint of the private company. The amount of balsam obtainable in the near future remains in doubt until the progress of the everywhere-prevalent fungous and insect diseases is determined. If the hardwoods could be utilized, their removal might result in a much larger portion of the young spruce reaching merchantable size. The possibility of utilizing white birch for pulpwood and yellow birch for railway ties is being investigated by the forester of the Laurentide Company. However, the whole question of the effect of the removal of biologically dominant hardwoods in stimulating the growth of suppressed conifers is still largely in the condition of theoretical discussion, and Dr. Howe's address closed with an earnest plea for definite experimentation in the various problems of forest regeneration in the north woods. Extensive studies of an intensive nature into conditions controlling forest reproduction on the cut-over lands are necessary before reasonably reliable predictions of future pulpwood supplies can be made, and such reliable predictions must be made possible before the newsprint price controversy can be settled on an equable basis.

Empire State Forest Products Association Meeting

The report of the proceedings of the twelfth annual meeting of the Empire State Forest Products Association, held at Utica in November, 1917, calls attention to a new phase in the forestry movement which is significant, namely, the employment of a technical forester by a group of timberland owners who are at the same time manufacturers.

It is true the National Lumbermen's Association has the priority in employing technical men to further their business, but we think we are not mistaken in believing their activity was used in developing markets, while the forester of the Forest Products Association appears to have his attention mainly directed to the woods end of the business, to real forestry work. A similar development may be noted in Canada with the formation of the woodland section of the Canadian Pulp and Paper Association, which has the same object in view and may eventually employ a technical forester.

The advent of Prof. A. B. Recknagel in this position seems to have given a new impetus to the efforts of the association, which in the previous eleven years of its existence have left hardly any impression. In the present report Recknagel merely clears the decks for action by canvassing the conditions of the membership of the association as to their ownership of timberlands and interests. It appears that nearly 1.4 million acres are represented in the association, 61 per cent of which is merchantable and only 12 per cent vacant and water, with an annual cut of around 650 million board feet in logs and cordwood, employing near 14,000 men.

One interest of the association, which was particularly accentuated by the president, lies in the direction of bringing the State of New York to a saner policy with regard to its forest preserve, which makes a "cemetery of 1,800,000 acres of potential forest area," an investment of approximately $4,000,000, and with "an annual appropriation for the care and maintenance of the cemetery . . . of $300,000." We need not expand to our readers an explanation of this extravagance, or should we say extravaganza. A lengthy discussion of the situation, in which both sides were represented, took place at the banquet.

We have no space to go into the details of the report. Among the addresses which are worth reading are Professor Hosmer's clear exposé of the forest taxation problem; Professor Toumey's discussion of the economic aspects of reforestation, in which the author pins his faith on private endeavor, although he furnishes cogent arguments against such expectation.

W. R. Brown sent a highly interesting account of his Timberlands Mutual Fire Insurance Company, recently formed in New Hampshire, which has already written policies close to $400,000. This is a development which we commend especially to the attention of our readers. It has led to a new profession, namely, that of "forest actuary."

The *Canada Lumberman,* editorially objecting to the extravagant statements made in popular magazines regarding the waste of wood in forest and mill, gives the following measurements of the longleaf pine trees: Of a 26-inch d. b. h. tree, 74.5 per cent of the total cubic contents, including stump and branches, went to the mill and 45 per cent was turned into lumber; of a 14-inch tree, 67 per cent went to mill and 46.5 per cent into lumber.

The Canadian Forestry Association held a well attended conference of two days, at Montreal, February 6 and 7. The association has now a membership of 6,200. Total receipts for the year were nearly $12,-000, of which $2,235 were secured through special subscriptions—a financial feat these war times! It is significant to note that a railroad man and a lumberman were elected president and vice-president, namely, Lieut.-Col. J. S. Dennis, of the Canadian Pacific Railway, and J. A. Gillies, of Gillies Brothers.

On January 7, 1918, the U. S. Senate, by a vote of 37 to 32, passed the Walsh-Pittman Oil and Coal Land Leasing Bill. This hill has been pending in the Senate for four years. If it passes the House and becomes a law, it will establish a new principle on the part of the Government in dealing with its mineral resources.

Under date of January 28, 1918, Mr. Gifford Pinchot sent a letter to various newspapers throughout the country commending the administration water-power bill recently introduced in the House of Representatives. The bill in question was formulated under the direction of the Secretary of Agriculture, the Secretary of War, and the Secretary of Interior. It deals with water power in National Forests, public lands, Indian lands, and navigable streams.

Mr. Pinchot says that it "embodies the principles essential for wise use and development of our public waters in the public interest. The passage of this law will secure to American people forever vast resources whose use for the good of all will make this land a safer and better place to live in." The bill has been referred to a special committee of the House, created to consider it.

The Nancy forest school has been temporarily removed to Paris, conditions at Nancy, due to the nearness to the war front, having become unfavorable to its continuance there. Fifteen to twenty students are expected to attend.

In November last a reorganization of various services charged to provision the armies with wood materials into a single *Service des Bois,* under the Minister of Munitions, was effected in France. It is to secure the various needs for wood by purchase in the market, by direct exploitation, or by requisition, and to organize a rational utilization of the means of production. For this purpose the country is subdivided into nine *Centres de Bois,* with a director presiding over each, of the grade of lieutenant-colonel, with the necessary staff. For the service of the softwoods a further division into *circonscriptions* (regional locations) in charge of a superior or subaltern officer; for the service of hardwoods one special *circonscription* is provided at each center.

At each center a company of forest laborers is maintained. An inspector-general exercises general supervision, co-ordinating the work and distributing orders for material and controlling the work in general.

SOCIETY AFFAIRS

Report of the Treasurer for the Year 1917

In this report it has been necessary to estimate liabilities in a couple of instances, so that the sum ($690.48) which represents excess of assets over liabilities is doubtless not absolutely correct. It is, however, not far from the mark. As in 1916, the budget system of allotting funds for expenditure was followed and in the main has proved satisfactory. It has not in several cases operated to keep expenditures within the amount originally allotted for the purpose. The amount allowed for publication and distribution of the Journal was $4 for each active member of the Society and all receipts from the sale of back numbers and separates of the Proceedings and Journal and from subscriptions, or an estimated total of $3,000. Additional estimated returns of $465 were allotted for expenditure to the various activities shown in the table, "Comparison of Estimated and Actual Receipts and Disbursements." The actual disbursements as shown by this table exceeded in four instances the estimated or the amounts allotted in the original budget. Authority was secured from the Executive Council to increase these allotments sufficiently to take care of the increased expenditures, and also to set aside from the reserve fund a sum of $75 to cover the cost of a military census of foresters in the United States.

The salient features of the financial condition of the Society are indicated by the figures in the accompanying statements. The excess of assets over liabilities is $690.48, as compared with $581.15 at the end of 1916, an increase of $109.33. A number of factors have contributed toward only a small increase in the balance. The receipts from annual dues were $86 less than anticipated. There was an unforeseen expenditure of $29.53 for a military census of foresters. The Editorial Board exceeded its allotment by $214.90; and the postage, stationery, and Academy of Natural Science allotments were exceeded by $19.38, $29.37, and 85 cents respectively.

A number of resignations from the Society and failure to pay dues by fourteen other members cut down the estimated receipts from this source.

Increased costs of printing and the necessity for changing from an unsatisfactory printer to a satisfactory, but more expensive, one had much to do with the Editorial Board's exceeding its allotment. The abundance of good material available for publication, resulting in some large but expensive editions, has also been a contributing factor. Even though the Editorial Board exceeded its allotment, the actual cost of the JOURNAL has been only 34 cents per copy—a decrease of 4 cents over that of the Proceedings in 1916.

The postage and stationery allotments were exceeded simply because of the increased activities of the Society. There has been a great deal more correspondence during the past year than in the previous one, with the consequent use of more stationery and postage. This is a tendency which should be noted in the preparation of next year's budget and due allowance made accordingly. Increased postal rates now in effect will augment this tendency.

The actual increase in receipts in each case, except from annual dues, over those estimated has been gratifying. Although fully 88 of the old subscribers to the Forestry Quarterly failed to subscribe to the JOURNAL OF FORESTRY, new subscriptions have nearly made up the loss. A large number of these were due to the efforts of the advertising and subscription manager. The sale of back numbers has been brisk and the first year's advertising campaign has exceeded expectations.

The Society should make a sustained effort for a number of years to accumulate a comfortable bank balance. During the last two years there has been some increase in this respect. It can be augmented through an increase in membership and in subscribers, by an increased number of advertisers, and last by curtailing expenses as much as possible. A greatly increased list of subscribers is desirable, particularly subscriptions by institutions, such as public libraries and colleges. These are perfectly reliable, will when secured probably continue indefinitely upon the subscription list, and when the nature of the publication is revealed to them will in some cases wish to purchase complete sets of back numbers. The supply of these now on hand will thus become a tangible asset.

With an increased subscription list, it is probable that it will be easier to build up the number of advertisers. Such concerns as handle sawmill machinery, rifles and revolvers, sporting-goods houses such as Abercombie & Fitch, houses handling woodsmen's shoes and clothing, and manufacturers of scientific instruments used by foresters should eventually appear as advertisers in the JOURNAL.

In the purchase of supplies, such as stationery, and in letting out printing contracts, the Secretary and Treasurer by carefully looking into the possible sources of supply and of printing can effect a considerable saving.

The Editorial Board can probably be more careful to cut its pattern to suit the cloth and not exceed its allotment. This will require careful figuring and possibly occasional issues of the JOURNAL of not more than 100 pages. The expenses connected with getting out eight numbers, 1,200 to the issue, of the JOURNAL, aside from the actual printing, has been during the year just closing about $500, or $62.50 per issue. If the JOURNAL is allotted $3,000 next year for publication and distribution of 8 numbers, there will be available $375 minus $62.50, or $312.50, to cover the actual cost of printing each issue. The Editorial Board should probably be allotted the sum of $3,000 again in 1918. At least $500 should be allowed for running expenses, making a total of $3,500. An estimate of receipts during 1918 follows:

Annual dues, present and prospective active members, 340 at $5	$1,700.00
Subscriptions, 600 at $3 each	1,800.00
Sale of back numbers and separates	100.00
Advertising	100.00
Interest on bank account	20.00
Total	$3,720.00

If receipts are equal to the estimate and expenditures do not exceed $3,500, the Society will be able to increase its assets by the sum of $220 at the end of the year 1918.

RECEIPTS

Balance on hand January 1, 1916					$614.26
Annual dues, active members—					
Previous to 1917			$8.00		
1917			1,507.00		
1918			13.58		
1919			.90		
				$1,529.48	
Proceedings and JOURNAL—					
Subscriptions:					
Vol. XI (1916)		$4.00			
Vol. XV (1917):					
Student	$24.25				
Regular	1,792.63				
		1,816.88			
Vol. XVI (1918)		213.86			
			$2,034.74		
Sale of back numbers—					
Proceedings		$115.50			
JOURNAL		12.00			
			127.50		
Sale of separates			11.75		
Advertising in JOURNAL—					
By commercial institutions		$75.00			
By educational institutions		32.25			
			107.25		
				$2,281.24	

Interest on bank deposit, Jan. 1–June 30, 1917		11.73	
Society pins		29.25	
Miscellaneous—			
Sale of back numbers, Forestry Quarterly	$43.25		
Remittance to cover drayage of reprints to depot	.50		
Reprints of B. P. Kirkland's article in in Vol. XV, No. 1	35.00		
(Check submitted to Society in error)			
Overpayments, duplicate payments, etc	33.12		
		111.87	
Total			$3,963.57
Grand total			$4,577.83

DISBURSEMENTS

Publication and distribution of JOURNAL OF FORESTRY, 1917—		
Printing 1,200 issue, Vol. XV, Nos. 1 to 7	$2,269.16	
Plates and line cuts	96.45	
Proofreading	160.00	
Envelopes for mailing	103.00	
Address stencils	10.05	
Addressing and mailing	44.75	
Postage and express	99.99	
300 reprints, Forest Terminology, Part I	31.50	
		$2,814.90
Miscellaneous printing—		
Circulars and ballots	$32.30	
Stationery—		
Envelopes, letter size	7.20	
Letter-heads	40.62	
Second sheets	10.85	
Carbon sheets	5.50	
Advertising—contract forms	3.00	
Billheads	11.50	
Index cards	6.00	
Postals	1.50	
Coin envelopes	1.20	
		87.37
Postage (exclusive of JOURNAL)		121.38
Addressing notices, envelopes, etc		2.51
File clerk, stenographer, and typewriting		36.35
Express, telegraph, telephone		.45
General meeting at Washington, Jan. 18, 1917		10.00
Directory, Washington Academy of Sciences		5.85
Advertising manager, soliciting advertising and subscriptions		17.29
Society pins		29.35
Dr. B. E. Fernow (Forestry Quarterlies sold in 1917)		42.17
Military census of foresters		29.53
Miscellaneous—		
Blankbook	$0.35	
Rubber stamps	1.75	

Street-car tickets	.25			
Refunds, returned checks	33.20			
Reprints, Kirkland's article in Vol XV, No. 1	35.00			
		70.55		
Total			$3,300.00	
Balance on hand			1,277.83	
Grand total				$4,577.83

ASSETS

Balance on hand	$1,277.83	
Sale of back numbers and separates	19.75	
Advertising	24.50	
Interest on bank deposit (estimated), July 1–Dec. 31, 1917	11.00	
Postal deposit	5.61	
Total		$1,338.69

LIABILITIES

Annual dues paid in advance—				
1918		$14.70		
1919		.90		
			$15.60	
Subscriptions to Vol. XVI, Journal of Forestry			213.86	
Journal of Forestry—				
Printing Vol. XV, No. 8 (estimated)		$400.00		
Distribution of No. 8 and back numbers (estimated)—				
Postage	$8.00			
Clerical help	2.50			
		10.50		
Addressing envelopes for mailing Journal		.75		
			$411.25	
File clerk (estimated)			2.50	
Miscellaneous printing (notice of Pittsburgh meeting, estimated)			5.00	
Total				$648.21
Excess of assets over liabilities				$690.48

Comparison of Estimated and Actual Receipts and Disbursements

RECEIPTS

	Estimated.	Actual. (Includes advance payments, 1916.)	Excess of actual over estimated.
Annual dues	$1,625.00	$1,539.00	—$86.00
Subscriptions to Journal	1,650.00	1,845.38	195.38
Sale of back numbers	75.00	159.00	84.00
Advertising	100.00	131.75	31.75
Interest on bank account	15.00	22.31*	7.31
Total	$3,465.00	$3,697.44	$232.44

DISBURSEMENTS

	Estimated.	Actual. (Includes advance payments, 1916.)	Excess of actual over estimated.
Editorial Board	$3,000.00	$3,214.90*	$214.90
Miscellaneous printing	100.00	37.30*	—62.60
Postage (exclusive of JOURNAL OF FORESTRY)	100.00	119.38	19.38
Stationery	60.00	89.37	29.37
Addressing notices, envelopes, etc.	10.00	2.51	—7.49
File clerk, stenographer, and typewriting	70.00	39.85	—30.15
Express, telegraphs, telephone	5.00	.45	—4.55
General meetings	35.00	10.00	—25.00
Directory, Washington Academy of Sciences	5.00	5.85	.85
Advertising manager	50.00	17.29	—32.71
Miscellaneous	30.00	2.35	—27.65
Total	$3,465.00	$3,539.25	$74.25

* Partly estimated.

C. R. TILLOTSON, *Treasurer.*

REPORT OF THE SECRETARY FOR THE YEAR 1917

Owing to the limited activities of the Society the past year, there is very little to report. The present Secretary was appointed in September to fill the unexpired term of former Secretary R. Y. Stuart, who had been called by the War Department for active field duty with the Engineers. Since that time the principal work, aside from routine and the annual election, has been preparation for the annual meeting at Pittsburgh in conjunction with the American Association for the Advancement of Science, December 31, 1917, and January 1, 1918.

REVISION OF THE CONSTITUTION

In June the final draft of the Constitution was prepared in accordance with the ballot on the various propositions for amendment placed before the membership last year. The revision was published in the December issue of the JOURNAL, together with a list of the members.

CHANGES IN MEMBERSHIP

No new members were elected during 1917, although 49 are before the Council for senior members.

Four members, whose names follow, resigned: R. F. Balthis, H. D. Burrall, H. S. Sackett, W. B. Barrows.

Seventeen members were dropped for non-payment of dues.

A number of members have been nominated for the rank of Fellow, created by the revised Constitution, but have not yet been submitted to the membership for ballot.

RECOMMENDATIONS

At present, in addition to handling the routine work of the Secretary's office, the Secretary is chairman of the Committee on Meetings, which requires a great deal of extra work and time. In view of the fact that the services are contributed free, it would seem that the burden of carrying on the work of the Society should be distributed among those so situated as to be able to carry it on in the best interest of the organization. There has been but one meeting of the Society as a whole during the past year, yet special meetings may be necessary from time to time, the arrangement of which is more properly the work of a special committee on meetings than of the Secretary. It is therefore recommended that such a committee be appointed for the ensuing year, the chairman of which shall be a Council member, as provided by the revised Constitution.

RESULTS OF THE ANNUAL ELECTION

The ballot closed December 20, and a list of those elected was published in the January issue. It should be observed that extra members have been elected for temporary periods to the Council to fill the unexpired terms of those members absent in the field service of the War Department. This was considered necessary in order to carry on the business of the Society requiring Council action.

E. R. HODSON, *Secretary*.

REPORT OF THE BOARD OF EDITORS FOR THE YEAR 1917

The Board of Editors has pleasure in reporting that the amalgamation of the two publications—the Proceedings of the Society and the Forestry Quarterly—in the JOURNAL OF FORESTRY has taken place without any difficulties except unavoidable delay of the first few issues of the JOURNAL.

The eight numbers of the year have contained nearly the maximum of pages (1,100) which we started out to furnish, and it is believed the character of the contents has at least maintained the standard of the original publications.

There has been an unusually large contribution of original articles, giving rise to a very large number on the waiting list, in spite of the fact that the other departments were considerably curtailed. It may be necessary for a few issues to confine the contents to original articles alone in order to take care of the contributions, which should, of course, take precedence to matter from other sources.

An analysis of the contents shows that the 658 pages of articles were distributed among six classes of subjects, namely:

	Pages
Mensuration, Finance, and Management	240
Silviculture, Protection, and Extension	215
Politics, Education, and Legislation	106
Soil, Water, and Climate	45
Utilization, Market, and Technology	44
Botany and Zoölogy	8

There were 5 plates, 10 cuts, and 19 diagrams. A complete index to the volume appears in the December number.

Book reviews and book notices were covered by 147 pages; the periodical literature, which, owing to the absence of all German publications, was relatively scanty, was briefed on 94 pages; 121 pages were devoted to news notes and comments; Society affairs were disposed of on 52 pages, and personals covered 28 pages.

It is contemplated to enlarge on the department of news, such as would interest the men who have enlisted and gone overseas, even to the extent of including items of more personal interest.

The Treasurer's report will also show that the estimate of the year's allowance for the JOURNAL of $3,000 was exceeded by around $215, due to the increased cost of printing.

It is hoped that the standard of the original articles submitted will continue to improve, and also that a more pronounced attitude in the editorial comment on the development of the profession and of the lumber industry may be taken.

B. E. FERNOW,
For the Editorial Board.

THE WAR COMMITTEE

The War Committee of the Society of American Foresters has recently been reorganized with Prof. J. W. Toumey as chairman. The following letter has been sent to the members of the committee:

"The needs of the country for the services of men engaged in war work who have had some technical training in forestry or vocational training in woods work and in the best utilization of wood are pressing, as shown in the recent call of the Army for at least 16,000 men proficient in the inspection of wood, in working in wood, in lumbering, and in other vocations relating directly to the handling and utilization of forest products in the conduct of war. It has been found desirable to extend the original war committee of the Society of American Foresters to include a wide representation of all the interests of the profession, such as national and State forestry, schools of forestry, and private forestry. I have been appointed chairman of this enlarged committee and have been charged with its organization. The members of the Society selected for this committee are drawn from widely separated parts of the country and represent all fields of the profession. They are as follows:

Executive Committee

James W. Toumey, Connecticut, *Chairman*
Raphael Zon, Washington, D. C., *Secretary*

Gifford Pinchot, Pennsylvania
E. H. Clapp, Washington, D. C.
Irving W. Bailey, Massachusetts
C. R. Pettis, New York

General Committee

Sydney L. Moore, Florida
Walter Mulford, California
P. S. Lovejoy, Michigan
Alfred Gaskill, New Jersey
A. B. Hastings, New Hampshire
R. S. Maddox, Tennessee
J. E. Rothery, New York
J. W. Sewall, Maine
R. S. Kellogg, Illinois
E. G. Cheyney, Minnesota
H. H. Chapman, New Mexico
A. K. Chittenden, Michigan
A. B. Recknagel, New York
F. E. Olmsted, California
W. T. Cox, Minnesota
Hugo Winkenwerder, Washington

"The chairman will arrange to give considerable time to making the work of this general committee effective. The executive committee is selected in reference to the members being able to meet at reasonably frequent intervals.

"The center of all war work is now in Washington. It is deemed important, therefore, to have a small executive committee of members either resident in Washington or who can attend necessary meetings on short notice. Questions arise in war time which must be settled at once, and it would be impossible to transact business with a large and scattered committee, as ours must naturally be in order to represent all the forestry interests of the country.

"An important function of the war committee is to be the spokesman on matters of national importance in which the profession of forestry is concerned. The need of such a committee was recently voiced in a resolution of the Society at the recent Pittsburgh meeting. Our main object should be to bring together every member of the Society in war work. If the Society is to be most useful, it must be prepared for concerted action. We are confronted at this time with a number of big problems, one of which is the wood-fuel campaign; another, the vocational training of forest engineers and timber workers for the needs of the Army. By means of this committee the Society of American Foresters can work with the Forest Service in much that the latter is now called upon to do.

"It is believed that the war committee of the Society can be made the unifying and guiding force in making the profession of forestry most proficient in war work, and I hope you will give me your hearty co-operation."

On March 28 the executive committee met in New York and discussed the war problems on which the Society of American Foresters can be of assistance to the Forest Service and to the other departments of the Government. The chairman was instructed to act as spokesman for the Society, co-operate with the Forest Service and the War Department in the solution of the problems confronting the country, and call upon the members of the Society for any special help along the lines in which they are particularly qualified. The problems which are to be taken up first will be formulated within a short time and the members who can assist in their solution will be drafted for this work. Meanwhile, all members of the Society are requested to send their suggestions for work that, in their opinion, should be done at present to the chairman of the committee, who will consider them and bring them to the attention of the different branches of the Government.

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Vol. XVI MARCH, 1918 No. 3

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JOURNAL OF FORESTRY

VOL. XVI MARCH, 1918 NO. 3

STUDIES OF YIELD AND REPRODUCTION OF WESTERN YELLOW PINE IN ARIZONA AND NEW MEXICO

By G. A. PEARSON

Forest Examiner, Fort Valley Experiment Station

Western yellow pine, because of its abundance, its accessibility, and the superiority of its product as compared with other local species, is and will always continue to be by far the most important timber tree in the National Forests of Arizona and New Mexico. In view of this situation it is but natural that silvical studies should be focused on western yellow pine. Not only its commercial importance, but also its silvicultural needs entitle this species to first consideration. Because of the adverse conditions under which it grows, the perpetuation of the western yellow pine forest in some sections of the Southwest is a matter of vital concern to foresters. This applies particularly to the National Forests on which exploitation has been greatest, namely, the Coconino and the Tusayan.

Studies of growth and reproduction of western yellow pine were among the first steps taken by the Forest Service in placing the forests of Arizona and New Mexico under management. These studies, being designed to meet the most urgent immediate needs as quickly as possible, were of necessity more or less incomplete and superficial. Studies of growth by the stem-analysis method are unsatisfactory for the irregular and many-aged stands in the Southwest, because they do not take sufficiently into account mortality and the effect of incomplete stocking, both of which are uncertain factors. Stem analyses indicate the rate of growth for individual trees, but the results are unreliable when applied to stands. Studies of natural reproduction were almost entirely by the historical method, that is, data regarding the factors favoring or retarding reproduction were deduced from the history, as far as it could be worked out, of typical areas on which reproduction was conspicuously present or absent. The difficulty with such studies in this region is that reproduction is normally so slow and uncertain, even under the most favorable conditions afforded by Nature, that it is often impossible without authentic records to establish any definite relation between cause and effect.

The shortcomings of the early investigations were quickly recognized, and steps were taken to solve the problems in a thorough manner. One of the methods of study adopted as particularly suitable for conditions in this region is the permanent sample-plot method. The principle is known to all foresters. In brief, the procedure is to establish plots on typical areas and maintain complete records of what takes place during a period of years. It involves more, however, than merely passive observation of results; it also involves painstaking inquiry into causes.

During the period from 1909 to 1915, 19 permanent sample plots aggregating about 2,000 acres were established mainly in pure western yellow-pine stands in Arizona and New Mexico. One of the plots is in a virgin forest, two are on private cuttings, and the remainder are on areas logged under Forest Service supervision. About 90 per cent of the acreage is in the form of "extensive" plots and 10 per cent in the form of "intensive" plots. On the "extensive" plots the trees are merely recorded by 1-inch diameters and classified as to "yellow pine" [1] or "black jack," "healthy" or "unhealthy." Supplementary records are kept for windfalls, trees struck by lightning, and attacked by mistletoe, porcupine, and other common enemies. The "intensive" plots, which are usually selected to represent large areas, rarely exceed 10 acres. In these the studies are much more detailed than is possible on "extensive" plots. Each tree is numbered and recorded separately, giving diameter, height, clear length, crown description, and full notes regarding the condition of the tree, particularly with respect to disease and injuries. A map on the scale of 1 inch or more to the chain gives the exact location of each tree down to 4 inches d. b. h., scattered seedlings and groups of reproduction 1 foot or over in height, stumps, brush piles, logs, tree-tops, logging roads, and in fact every feature which may be expected to affect the stand. On additional small plots, all seedlings over one year old are staked and numbered. On a few plots all vegetation, including herbaceous plants, is charted with a view toward determining its effect upon forest reproduction.

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[1] The older, or yellow-barked, trees are commonly designated as "yellow pine," while the younger, or dark-barked, trees are called "black jack."

The methods and general scope of these studies have been described in detail by Woolsey,[2] to whose foresight during the pioneer stage of forestry in this region their initiation is due. During the five years since Woolsey's article was written the methods have undergone considerable refinement. The scope has been broadened because it has been found that, with little additional field work, the records can be made to cover a more comprehensive field than was originally contemplated.

The plan calls for periodic measurements and examinations on each plot. Measurements and certain descriptive data will be taken at intervals of five or ten years. Other data, such as seedling records and records of seed crop, will be taken yearly on accessible plots. Special studies necessary to correlate growth and reproduction with physical factors are also a part of the program.

Four "extensive" plots, each including two "intensive" plots, on the Coconino and Tusayan National Forests were remeasured in 1914. All of these plots were established in 1909. All are in pure yellow-pine stands.

Two types of cutting are represented, namely, standard Forest Service cuttings and private cuttings.

The cutting method[3] on recent Service timber sales, as represented by plots Nos. 3 and 4, is a form of the selection system sometimes characterized as the group-selection system. Approximately two-thirds of the volume is removed, leaving one-third in the form of black jack or immature trees and a sufficient number of yellow pine or mature trees to insure an adequate seed supply and to preserve forest conditions. The slash on plots 3 and 4 was piled but not burned excepting on fire lines. In the old private cuttings represented by plots Nos. 1 and 2 silviculture was left entirely out of consideration; but the character of the remaining stands was from a silvicultural point of view not radically different from that of stands now left on Service cuttings. The private cuttings 20 to 30 years ago resemble the modern Service cuttings in that they left nearly all of the black jack and many of the full-crowned yellow pine, which according to present standards are considered desirable seed trees. They differ essentially from the Service cuttings in that much of the overmature and defective yellow pine was left. Utilization was very poor on the old cuttings and slash

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[2] Woolsey, Theodore S., Jr. "Permanent Sample Plots." Forestry Quarterly, Vol. X, No. 1, 1912.

[3] On a series of plots established in 1913 four methods of cutting and two methods of brush disposal are compared. Since these plots have not been remeasured, they are not included in this article.

was left as it fell. Plots 3 and 4 were logged in 1909, plot 1 in 1894, and plot 2 about 1895.

Only two site qualities have been recognized, although detailed studies would doubtless reveal minor variations. Plots 1, 2, and 3 are very similar and lie within a few miles of each other. All are characterized by a gently rolling topography and a clayey soil of basaltic origin mixed with basaltic rocks of various sizes. The mean annual precipitation is around 23 inches. The altitude is close to 7,200 feet. Plot 4 is distinguished from the others by the presence of a surface layer of black volcanic cinders varying from one inch to a foot or more in depth, the underlying soil being generally similar to that on the first three plots. This plot also lies at a slightly lower altitude and probably receives several inches less precipitation than the others.

The acreage, exclusive of "intensive" plots, is as follows: Plot 1, 243 acres; plot 2, 135 acres; plot 3, 456 acres; plot 4, 304 acres.

RESULTS

The results from "intensive" plots which deal with individual trees are for the most part omitted in this article, because the period of observation is too short to give reliable data of this character. For example, diameter measurements on individual trees for short periods are greatly affected by irregularities in the bark; height measurements taken with a hypsometer are apt to be from 1 to 2 feet in error; volume calculations based upon volume tables will be inaccurate because the individual tree departs more or less from the normal represented by the volume table. These irregularities will decrease as the period increases, although in the case of volume they must continue to be reckoned with. When the results deal with averages for a large number of trees, as in the "extensive" plots, inaccuracies of the character mentioned are apt to be relatively small, even when the record covers a period as short as 5 years. It is therefore felt that the data presented in this article, based almost entirely upon "extensive" plots, may be accepted as trustworthy when applied with a proper understanding of their limitations.

As has been previously indicated, distinction is made between black jack, or young trees, and yellow pine, or old trees. Black jack grows more rapidly, has a greater taper and lower form factor, and usually contains a lower proportion of merchantable material than yellow pine. Although the two classes are always distinguished in timber-sale practice, a clear line of demarkation is difficult to establish because the transition from black jack to yellow pine is almost imperceptible. The rule in all sample-plot work in this region is to class a tree as black jack until it is distinctly a yellow pine. Despite this precaution, it occasionally happens that a tree classed as yellow pine 5 years ago is now classed as black jack and vice versa. Trees are, however, continually passing from the black-jack stage to the yellow-pine stage, and the number which actually undergo this transition in a 5-year period may be very appreciable.

INCREASE IN NUMBER OF TREES

Tables 1 and 2 show considerable variation in the four plots with respect to number of trees, proportion of yellow pine and black jack, and increase from 1909 to 1914. There is, however, a general agreement in the preponderance of black jack over yellow pine. With the exception of plot 2, all show a slow rate of increase, plot 3 having an actual decrease.

The decrease in number of black jack as indicated for three of the plots in Table 1 is accounted for largely by the transition from the black-jack to the yellow-pine stage, while the increase in yellow-pine is due entirely to this transition. Unless the black jacks which grow into the 4-inch diameter class exceed in number those which pass into the yellow-pine stage, the black jacks will show a net decrease.

On all of the plots with the exception of No. 2 the low number of trees per acre indicates exceedingly incomplete stocking. This condition is accentuated by the fact that the trees occur in groups. Reference to the map of an intensive plot which is fairly typical shows that the space covered by the crown is approximately only one-fifth of the total area. In virgin stands usually less than one-half the area is covered by the crowns. To bring about more complete stocking is one of the problems of forest management. Here arises the question of what may be considered a fully stocked stand in western yellow pine. It is reasonable to believe that portions of the present open spaces are not fully utilized, but whether they could ever be filled so as to establish a continuous crown cover is uncertain. It is probable that the land, on account of the low and poorly distributed precipitation, would not support a continuous stand uniformly as dense as the present groups. This opinion is based upon the observance that roots commonly extend far beyond the crowns into adjoining openings. The present investigations should ultimately throw considerable light on this question.

TABLE 1.—*Number of Trees per Acre 4 Inches d. b. h. and Over*

Plot No.		Number, 1909.	Increase or decrease, 1909-1914.	Dead, 1909-1914. Number.	Dead, 1909-1914. Per cent of total.	New trees, 1909-1914.
1	Yellow pine....	3.41	0.54	0.12	3.5	.....
	Black jack.....	9.43	—0.42	0.01	0.1	0.25
	Total......	12.84	0.12	0.13	1.0	0.25
2	Yellow pine....	10.39	1.24	0.19	1.8	.....
	Black jack.....	18.88	18.36	0.20	1.1	19.99
	Total......	29.27	19.60	0.39	1.3	19.99
3	Yellow pine....	1.37	0.05	0.05	3.4	.....
	Black jack.....	16.74	—0.17	0.37	2.2	0.30
	Total......	18.11	—0.12	0.42	2.3	0.30
4	Yellow pine....	3.01	0.35	0.85	2.8	.....
	Black jack.....	12.35	—0.10	0.03	0.2	1.13
	Total......	15.36	0.25	0.88	0.7	1.13

TABLE 2.—*Composition of Stand*

Plot No.		Per cent of total number of trees, 1914.	Number of trees per acre in each diameter group, 1914. 4-11 inches.	12-20 inches.	21-30 inches.	31-40 inches.	41-50 inches.	Total, 1914
1	Yellow pine..	30.4	0.05	1.64	1.76	0.45	0.05	3.95
	Black jack...	69.6	3.04	5.00	0.96	0.01	....	9.01
	Total.....	100.0	3.09	6.64	2.72	0.46	0.05	12.96
2	Yellow pine..	23.8	0.49	5.08	5.54	0.50	0.02	11.63
	Black jack...	76.2	29.50	6.73	1.01	....	....	37.24
	Total.....	100.0	29.99	11.81	6.55	0.50	0.02	48.87
3	Yellow pine..	7.9	0.09	0.23	0.80	0.29	0.01	1.42
	Black jack...	92.1	5.53	7.49	3.45	0.10	....	16.57
	Total.....	100.0	5.62	7.72	4.25	0.39	0.01	17.99
4	Yellow pine..	21.6	0.43	1.49	1.20	0.22	0.02	3.36
	Black jack...	78.4	5.31	5.41	1.44	0.09	....	12.25
	Total.....	100.0	5.74	6.90	2.64	0.31	0.02	15.61

Reasonably prompt restocking after cutting is one of the obvious requisites to successsful silviculture. Comparatively little loss due to overmaturity and disease is expected on Forest Service cuttings, because practically all trees thus affected are removed in cutting. On the other hand, a great increase in number of trees due to development of advance growth and reproduction should take place. In reality, however, only one of the plots considered in this study shows appreciable progress in this direction. Although trees below 4 inches d. b. h. are not recorded, it is possible to predict from observations whether or not a stand is on the way toward satisfactory restocking. Thus, a great increase on plot 2 during the next 5 or 10 years is anticipated; on plot 1 there will be a slow but substantial increase, but on plots 3 and 4 no appreciable increase can be expected within 20 years. This leads to the subject of natural reproduction, which will be discussed later.

CONDITION OF STANDS

The percentage of unhealthy trees (Table 3) is a good index to the general condition of the stand. In this study trees are not classified as unhealthy unless they are decidedly so. Thus, many which show slight

TABLE 3.—*Condition of Stands in 1914*

Plot No.		"Unhealthy," per cent.	Struck by lightning, per cent.	Mistletoe-infected,[a] per cent.	Injured by porcupine,[a] per cent.
	Yellow pine........	20.4	7.6	....	....
1	Black jack	5.1	0.3	....	....
	Total..........	12.5	2.5	No data	No data
	Yellow pine........	22.2	3.4	....	....
2	Black jack.........	11.0	0.04	....	....
	Total..........	13.7	0.8	No data	No data
	Yellow pine........	7.0	3.4	34.8	0.8
3	Black jack.........	11.0	0.6	34.0	8.1
	Total..........	10.8	0.8	34.0	7.5
	Yellow pine........	0.0	2.1	0.0	0.0
4	Black jack.........	2.2	0.3	0.0	0.2
	Total..........	3.8	0.6	0.0	0.1

a Trees infected by mistletoe or injured by porcupines are not necessarily "unhealthy."

injuries or infection by mistletoe, if otherwise vigorous, are still classified as healthy. The outstanding feature of Table 3 is the high percentage of unhealthy yellow pine on the old private cuttings, plots 1 and 2. As previously explained, this is due to the fact that most of the defective trees were left standing. The black jack on these plots compares favorably with the plots cut under Service regulations.

The high percentage of unhealthy black jack on plots 2 and 3 is due to mistletoe. On plot 3 many young trees are being killed by this pest. The records show a loss of 1.5 per cent of the black jack on plot 3 from 1909 to 1914, due to mistletoe alone or in conjunction with other factors. While this figure is not alarmingly high, the indications are that the death rate will increase from year to year. Although when this area was marked for cutting an effort was made to remove all badly mistletoe-infected trees, it is evident that mistletoe was not given the attention it requires. Mistletoe presents one of the most serious silvicultural problems in this region. The facts at hand point to heavy cutting as the only practical remedy, although it is probable that the removal of lightly infected trees would not be generally warranted. Since the mistletoe problem has recently been made the subject of a special investigation by Long and Korstian, whose report will soon be published, no detailed discussion will be entered into in this article. It is worthy of note that no mistletoe is reported on plot 4. No mistletoe occurs on western yellow pine in the entire cinder region represented by this plot, while elsewhere on the Coconino Forest and generally throughout the two States it is abundant.

The porcupine is responsible for much damage on certain areas. Saplings are frequently killed by girdling. Trees are seldom killed, but the leaders are often girdled, thus setting the trees back from 3 to 10 feet or more in height. A new leader is usually formed and eventually all external traces of the damage may disappear. Usually, however, there is a bend and a pronounced constriction in the stem. This peculiarity is very common in yellow pine. Doubtless the porcupine is responsible in most instances.

Squirrels do a considerable amount of damage in certain localities by cutting off terminal shoots. It is not uncommon in the winter time to find several hundred shoots 6 to 8 inches long beneath a tree. This greatly reduces the active leaf surface of the crown.

Of the agents listed in Table 4 as responsible for the death of trees, the most important are windfall, lightning, mistletoe, and bark beetle.

Windfall is being partially controlled on timber sales by leaving only the trees which are windfirm. This means avoiding very tall trees in excessively exposed situations and trees which before the cutting were protected by neighbors which are to be removed. The sample-plot records show that windfall is confined almost entirely to yellow pine of the larger diameters. Since, however, the maximum loss on any of the four plots was only 1.12 per cent of the yellow pine in five years, a detailed analysis of the factors involved is not warranted at the present time. When the records have been continued ten years they should begin to yield valuable data.

TABLE 4.—*Classification of Dead Trees, 1909-1914*

Cause of death.		Per cent of dead trees based on total number living on plot in 1909.			
		Plot 1.	Plot 2.	Plot 3.	Plot 4.
Windfall	Yellow pine	0.24	0.07	1.12	0.98
	Black jack	0.00	0.04	0.16	0.00
Lightning	Yellow pine	0.97	0.57	0.96	0.65
	Black jack	0.00	0.00	0.07	0.03
Mistletoe	Yellow pine	....	0.14	0.00	....
	Black jack	....	0.08	0.58	....
Mistletoe and insects	Yellow pine	....	0.36	0.16	....
	Black jack	....	0.00	0.77	....
Mistletoe and porcupine	Yellow pine	....	....	0.00	....
	Black jack	....	....	0.12	....
Insects (bark beetles)	Yellow pine	0.72	0.64	0.16	0.87
	Black jack	0.00	0.27	0.17	0.10
Porcupine	Yellow pine	....	....	0.00	....
	Black jack	....	....	0.12	....
Suppression	Yellow pine	0.12	0.00	0.00	....
	Black jack	0.00	0.14	0.03	....
Suppression and mistletoe	Yellow pine	....	....	0.00	....
	Black jack	....	....	0.03	....
Cut in trespass	Yellow pine	1.09	0.00	....	....
	Black jack	0.13	0.50	....	....
Others	Yellow pine	0.12	....	0.00	0.00
	Black jack	0.00	....	0.05	0.03
Unclassified	Yellow pine	0.24	....	0.80	0.33
	Black jack	0.00	....	0.04	0.08
Total	Yellow pine	3.50	1.78	3.40	2.84
	Black jack	0.13	1.06	2.20	0.24
	Total	1.03	1.27	2.30	0.75

In the spring of 1917 unusual damage resulted from heavy snow at Flagstaff, Arizona. Twenty-eight inches of wet snow fell April 17 and 18. Practically all of this adhered to the branches, with the result that not only did branches break, but trees went down. Since the storm was unaccompanied by strong wind, the effect is attributed mainly to the weight of snow.

Lightning damage, like windfall, is confined almost entirely to large yellow pine. The mean annual loss in yellow pine on the four extensive plots is 0.16 per cent of the total number. Taking volume as a basis, the percentage would be higher. The loss in black jack is almost negligible, the average number for the four plots being only 0.02 per cent per year. The data for these sample plots were combined by Woolsey[4] with data from forests throughout Arizona and New Mexico. Among his deductions are the following:

Tall yellow pines are most liable to be struck; 23.2 per cent of the trees struck are topped or shattered; about 60 per cent of the trees struck by lightning are killed; beyond the tendency of lightning to strike on high points or ridges, no relation between topography and lightning damage is apparent.

Insects show sufficient activity to warrant attention. Practically all of the insect damage in trees above the sapling stage is due to bark beetles (several species of *Dendroctonus and Ips*). The attacks are at present confined to the killing of occasional trees. There is no record of extensive devastations in this region. Notwithstanding the absence of serious damage, however, the presence of species of bark beetles which are known to have been destructive to western yellow pine in other regions should be regarded as a latent menace capable of assuming dangerous proportions.

The record of deaths from suppression will prove exceedingly valuable, because no data on this subject are available. Although the yellow-pine stands in the Southwest are very open, the grouping habit results in the suppression of many trees. The records on "intensive" plots where each tree is numbered and charted will in time prove specially valuable; but results from such plots are not given here because the period is too short. In fact, the deaths from suppression recorded on "extensive" plots are mainly the result of conditions before cutting. Many trees below merchantable size in dense groups of black jack, however, still remain in a suppressed state. The records will show how long trees of different ages can persist when overtopped and also their capacity to recuperate when released by cutting.

INCREMENT

Table 5 shows annual board-foot increments per acre ranging from 31.7 to 145.8, and corresponding cubic increments ranging from 5.44

[4] Woolsey, Theodore S., Jr. "Lightning Damage in Western Yellow Pine." F. S. Circular Letter SI, D-3, March 10, 1915. (Not published.)

to 29.61 feet. The latter, while not expressed in our commercial unit, are theoretically more accurate than the former, since they are not subject to the well known inaccuracies of log scales. The increments as expressed in the two units are not strictly comparable because the board-measure increment considers only merchantable content, while the cubic-measure increment considers the entire stem, including stump. It should be noted also that cubic volumes in Table 5 include all trees down to four inches in diameter, while board-measure volumes include only the trees 12 inches and over.

The increment data presented in Table 5 will appeal to the silviculturist as something tangible and usable in his work. These are doubtless the most reliable data available for the region covered, but they should be accepted with a full understanding of their limitations, which are briefly outlined in the following paragraph.

Growth data based upon a period of five years cannot be regarded as representing the normal rate of growth during a rotation. Climatic conditions during the period covered may be above or below normal. Investigations by Douglass[5] show pronounced fluctuations in the width of annual rings, which have been associated with periodic fluctuations in precipitation. Moreover, assuming constant climatic conditions, the rate of growth in an even-aged cut-over stand would vary over a period of 20 or 30 years, due to competition between the trees for moisture and light. Considering competition alone, we should expect a great acceleration of growth in individual trees immediately after cutting, and a gradual falling off as the density approaches that of a fully stocked stand. There would also be a falling off in those trees which passed the age of maximum growth rate. Greenamyre found from stump analyses on a 26-year-old cutting near Flagstaff that a marked increase in diameter growth took place the first year after cutting and continued up to the time of the investigation. He estimates the period of accelerated growth at 40 years. The greatest response was shown by trees 40 to 80 years old, but was evident in trees 200 years old. The increment of a stand as a whole would, assuming a normal rate of restocking, be affected more by the entrance of new trees than by the variation in growth of individuals already on the ground. Therefore, while the slowing up in individuals after a period of 30 or 40 years would tend to decrease the current

[5] "The Climatic Factor as Illustrated in Arid America." Prof. Ellsworth Huntington, with contributions by Charles Schuchert, Andrew E. Douglass, and Charles J. Kullmer. Carnegie Institution, Washington, D. C.

annual increment, this might be more than offset by new trees growing into merchantable size.

A glance at the table at once reveals a wide range of increment on various plots. In accounting for these differences, a great many factors must be taken into account. These factors fall into two general classes, namely: Site quality, or the physical conditions affecting growth; and growing stock, comprising density, distribution, age, and condition of the trees. Method of cutting is important only in so far as it affects the above factors.

A comparison of plots 3 and 4 is interesting, since both were cut in the same year, under Forest Service regulations and according to the same silvicultural system. Plot 3 shows the higher increment in both board feet and cubic feet. This relation is in accordance with what may be expected from a comparison of the two sites, since plot 3, on the basis of available information, offers the better conditions for growth. The table, however, also shows plot 3 to be more fully stocked than plot 4. In fact, when the two plots are compared on the basis of increment per cent, or increment in proportion to growing stock, the advantage is on the side of plot 4.

The annual board-foot increment from 1909 to 1914 is only 2.07 per cent for plot 3 against 2.40 for plot 4, while the cubic increment per cents are 1.91 and 2.07 respectively. This means that plot 4 is yielding a higher return for the capital invested than is plot 3, which contrary to what might be expected from a comparison of the sites.

The probable explanation of the above discrepancy is to be found in the condition of the stand. The difference in age classes, as indicated by the proportion of yellow pine and black jack, is in favor of number of trees as against 21.6 per cent for plot 4. The real explanation appears to be in the proportion of unhealthy trees. On plot 3, 10.8 per cent of the trees are classed as unhealthy, while on plot 4 only 3.8 per cent are thus classed. A comparison of healthy and unhealthy trees of all diameters on an "intensive" plot shows the basal area accretion in the latter to be from 30 to 50 per cent lower than in the former. A similar comparison of mistletoe-infected trees of all diameters and degrees of infection with normal uninfected trees on the same plot showed the infected trees to be 40 per cent below the uninfected. Mistletoe is reported on 34.9 per cent of all the trees on plot 3, while on plot 4 there is no mistletoe whatever.

Both the lowest and the highest yields are recorded on the old cuttings, plots 1 and 2. The former shows an annual increment of only 31.7 board feet and 5.44 cubic feet per acre as against 145.8 and 29.61

respectively for plot 2. The increment per cents exhibit a corresponding relation. A portion of the excess increment on plot 2 is accounted for by the entrance of new trees. During the 5-year period covered, the mean increase in number of trees 12 inches and over in diameter per acre was 1.18 on plot 2, against 0.23 on plot 1. The difference in trees below 12 inches is still greater, although these trees do not enter into the board-foot volumes, and since most of them are in the 4 and 5 inch classes they do not represent a great cubic increment. Possibly a portion of the difference in growth rate is attributable to site quality. The health of the stands is probably another factor. These are subjects which require further investigation.

TABLE 5.—*Increment*

[Board measure includes trees 12 inches and over, d. b. h. Cubic measure includes trees 4 inches and over, d. b. h.]

Plot No.		Volume per acre, 1909.		Mean annual increment per acre, a 1909-1914.		Mean annual increment per cent, 1909-1914.	
		Ft. b. m.	Cubic ft.	Ft. b. m.	Cubic ft.	Ft. b. m.	Cubic ft.
1	Yellow pine...	2,140	380.0	43.3	8.20	......	......
	Black jack....	2,360	255.0	—11.6	—2.76	......	......
	Total......	4,500	635.0	31.7	5.44	0.99	0.86
2	Yellow pine...	4,780	885.5	154.2	27.50	......	......
	Black jack....	1,160	303.6	—8.4	2.11	......	......
	Total......	5,940	1,189.1	145.8	29.61	2.45	2.49
3	Yellow pine...	1,180	205.4	5.3	0.97	......	......
	Black jack....	2,336	529.5	67.5	13.54	......	......
	Total......	3,516	734.9	72.8	14.51	2.07	1.91
4	Yellow pine...	1,306	241.0	23.3	4.40	......	......
	Black jack....	1,205	303.9	37.6	6.90	......	......
	Total......	2,511	544.9	60.9	11.30	2.40	2.07

a Board measure, Scribner Decimal C Scale.

Another subject on which this study is expected to throw light is the effect of distribution upon growth. On all of the plots the great majority of the trees occur in dense, practically even-aged groups separated by large openings. Records on "intensive" plots show almost invariably a much greater diameter growth for trees in the open than for trees in large groups. Continued records will probably prove that the groups are too dense for maximum volume production. On the other hand, it is quite obvious that the larger openings in virgin as well as in cut-over stands could be more heavily stocked without causing harmful competition.

TABLE 6.—*Reproduction*

Plot No.	Number of 5 by 10 foot plots.	Total number of seedlings.										
		1909.		1914.			1915.			1916.		
		Under 12 inches.	12 inches and over.	1 year.	2 to 12 years.	12 inches and over.	1 year.	2 to 12 years.	12 inches and over.	1 year.	2 to 12 years.	12 inches and over.
1 A	8	3	0	2	2	2	0	4	2	1	2	3
1 B	10	3	1	6	7	1	0	10	1	20	6	1
2 A	7	0	0	5	5	0	0	6	0	6	4	0
2 B	7	0	0	1	16	0	1	17	0	8	11	0
3 A	10	1	0	34	0	0	0	3	0	0	2	0
3 B	10	0	0	43	1	0	0	9	0	0	4	0
4 A	8	1	0	0	0	0	0	0	0	0	0	0
4 B	8	0	0	0	0	0	0	0	0	0	0	0

Investigations by Weitknecht in eastern Oregon show that the diameter accretion in western yellow pine after cutting is considerably greater at breast height than further up the stem, and therefore increment figures based upon breast-high measurements will be too high. This question has not been investigated in the present study, but undoubtedly it demands consideration. It is believed, however, that the discrepancy between growth at breast height and at other points in the stem will be less in Arizona and New Mexico than in Oregon, because in the former region the bulk of the reserved stand occurs in groups which were practically undisturbed in cutting.

NATURAL REPRODUCTION

The seedling record in Table 6 indicates that reproduction is progressing unsatisfactorily. These results are typical of considerable portions of the Conconino and Tusayan National Forests. It is a discouraging fact that on none of the areas cut by the Forest Service on these two forests has good reproduction taken place since the cutting.

Some areas bear excellent seedling or sapling growth, but the bulk of this was on the ground at the time of cutting. This situation gives rise to apprehension regarding the future of cut-over lands. The studies which have been made, however, indicate that reproduction, while by no means certain, is likely to come ultimately. The period may be 30 years or even longer, depending upon a large number of circumstances. These conclusions are based upon results on old cuttings in which the stand was left in approximately the same condition as on present-day Service cuttings. A study of the table reveals the fact that the poor reproduction is due not so much to a lack of germination as to a high rate of mortality among young seedlings. Excepting in plot 4, fair crops of seedlings have started from time to time, but they have failed to establish themselves in adequate numbers. The same story is told by other plots and by general observation on cut-over areas and in virgin stands alike. In 1910 and 1914 good, though not dense, stands of seedlings sprang up quite generally on the Coconino National Forest, but today the survivors, except in favored localities, are very few.

Most of the seedlings die during the first season. Germination does not take place until the advent of the summer rains, in July and August, and consequently the seedlings make only about two months' growth the first year. If the summer rains are regular and if the autumn is not too dry, they get a fairly good start, but such conditions are exceptional. Innumerable seedlings die from temporary droughts in the rainy period. Those which survive are subjected to a further trial in September and October, when they are endangered not only by drought but also by frost.

In addition to the short growing season, the development of seedlings is further retarded by compact soils, which resist penetration by tender roots. An investigation at the Fort Valley Experiment Station in 1917 showed root lengths for natural western yellow-pine seedlings as follows: One-year-olds, average 6.4 inches, maximum 9.5 inches; 2-year-olds, average 9.2 inches, maximum 12.7 inches; 3-year-olds, average 10.5 inches, maximum 14.2 inches. In most years the soil moisture during the month of June is reduced to a point where it is no longer available to plants in the soil strata reached by the average 1 and 2 year old seedlings. Thus it is only the exceptional individuals of the 1 and 2 year classes which have a chance to survive, and in extremely dry years even 3-year-old seedlings are taxed to the utmost. Since nursery-grown seedlings commonly attain a root length of 10 to 12 inches in the second year, the slow development under natural conditions may be attributed to the compact adobe soil characteristic of the greater portion of this region. Another cause of loss in heavy soils is ground heaval, due to alternate freezing and thawing of the upper soil strata. Plants whose roots do not extend below the strata affected by this action are often thrown completely out of the ground. Severe frosts early in the fall, before the seedlings have time to harden, may result in wholesale losses, although this has occurred only once during the 9 years in which the writer has been in this region.

After the period of infancy the seedlings are still endangered by a long list of enemies. Most prominent among these are fire, snow pressure, grazing, and insects.

Fire usually kills all seedlings which happen in its path. Fortunately ground fires, unless there is a large amount of grass or slash, seldom make a clean sweep. The survival of occasional patches of reproduction on burned areas is due to this circumstance. The extent to which the failure of reproduction in the past has been due to fire is difficult to determine. Severe fires, such as occur in slash after cutting, leave a distinct imprint in the form of fire scars on living trees, and thus the year of occurrence can be determined. Light fires, which merely kill seedlings but do not injure trees, are more apt to escape notice. There is little doubt that in most cases where virgin forests lack reproduction in the openings, where it could grow without coming into destructive competition with older trees, fire is the controlling factor. With our fire-protection system continually reaching a higher state of perfection, this source of damage will be greatly reduced in the future. It should be borne in mind, however, that a fire once in 20 years may keep out reproduction.

It has recently been discovered that snow does more damage to seedlings than was formerly appreciated. In the spring of 1916 a plot of broadcast sowing containing a dense stand of 2-year-old seedlings showed severe damage. The seedlings were broken at the ground line by the weight of the snow. On a number of sample plots south of Flagstaff seedlings 5 to 10 years old are commonly bent and otherwise deformed without showing signs of insect or grazing damage. The evidence points to snow as being the cause.

No diseases have been reported as doing serious damage to seedlings in this region. Possibly this is because too little is known about diseases by forest officers. Mistletoe attacks saplings, but rarely appears on seedling growth below 3 feet high.

Grazing, particularly by sheep, is responsible for much damage in certain localities. The severest damage is on the Coconino and

Tusayan National Forests, due probably to the fact that here grazing has for many years been very intensive. This problem has been studied by the writer in connection with permanent sample plots and otherwise since 1908. A more comprehensive study has been made on the Coconino National Forest by the Office of Grazing.[6] This investigation, which covers three years of intensive study over an extensive range of territory, shows that an average of 16 per cent of the pine seedlings are severely injured and 21 per cent moderately injured each year by grazing. On overgrazed areas 35 per cent of the plants are severely injured. Sheep are responsible for by far the greater portion of these injuries. The greatest damage by all classes of stock results when forage is scarce or unpalatable. This condition prevails on overgrazed areas; on ranges where the predominant forage plants are coarse bunch grasses which are not readily eaten by sheep, and on all types of range during those seasons when the herbaceous forage is dry. A common cause of excessive damage is poor distribution of water, which causes overstocking on areas close to water and understocking on areas remote from water. Grazing damage could be reduced to a negligible quantity by the exclusion of sheep, but a general application of such a measure is not economically desirable. The remedy appears to lie in control rather than in exclusion. Proper regulation, however, is difficult to apply under present conditions because it involves shifting stock from one part of the forest to another, as circumstances require. Stock cannot be moved about at will, because the range water is developed at private expense, and after a stock-owner has developed water on a particular range he cannot in justice be required to leave this range and the improvements he has put on it. The ultimate solution of this problem lies in Government ownership of water and fences necessary to handle stock in the desired manner. Not until the Government owns the permanent range improvements will it be in a position to control grazing in the interest of the best development of the forest. When it is considered that grazing is one of the few large factors detrimental to forest reproduction which lie within the power of man to control, the urgency of action on this problem must commend itself to every forester.

Another side of the grazing problem deserves mention. By keeping down the amount of inflammable material, grazing decreases fire damage to reproduction. When the forage crop is not removed, dead grass

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[6] Hill, Robert R. "Effects of Grazing upon Reproduction on the Coconino National Forest." Report to be published as a Forest Service bulletin.

and other material accumulate in such quantities that when a fire occurs it is much more intense and usually covers a larger area before it can be controlled than is the case where the land is grazed. Trampling by stock in the fall and early spring aids germination by covering the seed. Overgrazing to the extent of exterminating perennial grasses just before the reproduction period begins would undoubtedly assist in the establishment of pine seedlings by reducing competition for soil moisture. These facts, however, constitute no argument in favor of unregulated grazing, since it is possible to secure practically all the benefits of grazing without subjecting the forest to serious damage.

One of the worst enemies to reproduction is the tip moth (*Evetra bushnelli* and *E. neo-mexicana*). The larvæ of these insects destroy the growing shoots and thus deform the young tree. Attacks begin when seedlings are 3 or 4 years old and continue until they are about 6 feet in height. Usually the plants recover after being held back for several years. If, however, the attacks are repeated year after year new foliage is prevented from forming and the plant is starved. Present knowledge suggests no remedy for this pest, aside from the action of natural enemies.

Another insect pest is the common May-beetle or June-bug, the larvæ of which feed on the roots of seedlings. This insect is most injurious to planted stock, since it prefers loose soil for egg deposition, but it also attacks natural reproduction.

On the whole, studies of western yellow-pine reproduction have given much information in regard to conditions under which seedlings die, but comparatively little definite knowledge regarding conditions under which they survive. The present silvicultural system has been in practice on the Coconino and Tusayan for 10 years, but, aside from the development of advance growth already present at the time of logging, there has been little progress in reproduction. This does not prove the system a failure, because during the same period results under other methods of cutting and in virgin stands appear to have been no better. The experience does, however, cause us to reflect and ask if we have not expected too much of silviculture. One idea has begun to stand out clearly, and that is that reproduction is controlled by something far more potent than silvicultural practice. The one dominant factor or complex of factors is climate. This so far overshadows all human efforts that the latter become relatively insignificant. This fact has been recognized in a general way, but nevertheless the idea persists that somehow a method of cutting or brush disposal may be evolved which will overcome the reproduction difficulty. It is almost a certainty that reproduction of western yellow pine will, regardless of silviculture, continue indefinitely to be a problem in certain sections of the Southwest. On rare occasions dense reproduction will spring up spontaneously, as it has done in the past, but when this happens it will be due more to favorable climatic conditions than to silviculture. Given a good seed crop, followed by suitable climatic conditions over a period of 2 or 3 years, and seedlings will spring up in abundance. Efforts to discover regularity in the occurrence of this combination have thus far not been rewarded with success. The climatic phase of the problem is complicated by the fact that favorable conditions over at least two consecutive years seem to be required. Just what the conditions are has not been definitely ascertained, but it is quite certain that moisture plays the leading rôle. Good seed crops are even more irregular than rainfall. This is due partly to the fact that cones often fail to mature. Whatever may be the explanation, it is a fact that such a thing as a general seed crop over the yellow-pine type is a rare occurrence.

If we wish to depend entirely upon the chance occurrence of large seedling crops under the conditions above described, all the silviculture that is needed for reproduction is to leave sufficient seed trees. There is, however, another process by which a forest may be restocked. Every two or three years a few seedlings succeed in establishing themselves. If these seedlings are protected, they will in the course of two or three decades establish a stand which though uneven-aged and irregular, is nevertheless better than nothing. This process, though slow, is more certain than the first, and therefore it should be the mainstay of our regeneration scheme. Here is where silviculture can be called into service. In years of most adverse conditions it will be of little avail, but in average years it will be more or less effective. If by proper management reproduction can be increased by 25 per cent in a given period, or the period required for complete reproduction shortned by 5 or 10 years, the result may be considered worth the effort. What the net result will be under a given set of conditions cannot be easily predicted; but one thing seems fairly certain: no matter what silvicultural system is practiced, reproduction will come slowly unless there should be a coincidence of unusually favorable natural conditions such as appear to have occurred at irregular intervals in the past.

In order to solve the reproduction problem, sample plot records must be supplemented by fundamental studies to determine: (1) What are the specific conditions required for reproduction? (2) How nearly are these requirements normally approached in Nature? (3) To what extent can adverse natural conditions be ameliorated by silvicultural practice?

At present the above questions can be answered only in general terms. Specific and accurate data, which can be secured only by most detailed investigations, are required. Such investigations present many difficulties because of the complexity of the factors involved, and because the road has not been paved by investigations in allied sciences. Since the problem of plant relations to habitat factors is now absorbing the best talent in botanical science, it is to be hoped that before many years new discoveries will come to our assistance. With the methods of investigation now available, however, much can be learned regarding the reproduction of western yellow pine.

SUMMARY

This article should be regarded as a progress report on an investigation which is barely begun. Although valuable data have already been secured, the chief value of the work up to the present time lies in the development of methods and the establishment of records for future reference. Full returns will begin to be realized only after 20 or 30 years.

The western yellow-pine forests in this region are as a rule not fully stocked. The main reason for this is poor natural reproduction. Most prominent among the agents responsible for the death or injury of trees past the sapling stage are mistletoe, insects, porcupine, lightning, and wind.

Increment data cover too short a period to furnish a reliable basis for calculating yield. The indications are, however, that an annual increment of 2 per cent of the growing stock on cut-over areas is a conservative figure. In average stands this means an annual growth amounting to from 50 to 75 board feet. Where natural reproduction brings about rapid restocking, the above figures may be greatly exceeded during the first 40 years after cutting.

Natural reproduction is the greatest and most far-reaching silvicultural problem with which the forester has to contend in this region. In certain sections reproduction is good, but on the National Forests, where exploitation has been greatest, reproduction is generally unsatisfactory. This situation is due largely to natural conditions, foremost among which is insufficient or poorly distributed precipitation. Silviculture can never wholly overcome the difficulty. All it can rea-

sonably be expected to do is to throw the weight of man's endeavor on the right side of the balance. The extent to which management can be depended upon to expedite reproduction is a matter requiring further investigation.

Next to unfavorable climatic conditions, the factors most inimical to reproduction of western yellow pine are fire, unregulated grazing, and insects.

On extensive areas fire has vitiated the efforts of the forest to perpetuate itself With the present fire-protection system in effect, damage from this source will in the future be greatly reduced. Notwithstanding this fact, when it is considered that the recurrence of fire on a given area once in 20 years may nullify all progress in reproduction, the importance of this factor can scarcely be overestimated.

Grazing animals, especially sheep, are responsible for much damage. On the other hand, grazing is beneficial, in that it facilitates the control of fires, aids germination by covering tree seeds, and decreases competition between tree seedlings and herbaceous vegetation. The solution of the grazing problem lies in regulation rather than exclusion of stock. Since this is one of the few large factors capable of control, it demands serious attention.

Insect damage ranks with fire and grazing damage. Unfortunately, no practical means for controlling the insect enemies of forest reproduction in this region are at present available.

ASPEN AS A TEMPORARY FOREST TYPE

By Frederick S. Baker

Forest Examiner, Utah Experiment Station, Ephraim, Utah

An article by Mr. Fetherolf[1] has lately appeared, which presents very clearly the arguments for considering aspen as a permanent type in the Great Basin region. Since, however, the article by Sampson[2] mentioned only the finding of coniferous charcoal in a pure aspen stand as an evidence of the essential instability of the local aspen, it may perhaps be well to sum up all the evidence showing the temporary nature of the aspen, for the question of its permanence is of great importance in this region.

It must be admitted at the outset that the aspen stands of the Great Basin are certainly not ephemeral, but have probably existed much as they are now for many generations and will doubtless last for many more. Accordingly they have the appearance of permanence. In Colorado and New Mexico, when conditions are similar, the temporary nature of the aspen stands is not questioned, because the coniferous climax is generally further advanced, and there is not even an appearance of stability or even of long duration. Duration, however, is no criterion of true stability.[3]

As defined by the Forest Service, a permanent or climax type is "a forest type which will eventually take possession of and perpetuate itself on any given area if natural conditions are undisturbed."[4]

Therefore if aspen is giving way to conifers at all within its "permanent" range, it is essentially transitory and a subclimax stage in the succession. Fetherolf holds, however, "that there is no conifer in the district with exactly the same requirements and qualities as aspen; hence there is left a strip or belt, as it were, in which no native conifer can replace it, with or without the help of fire, just as there is a belt in which tree species cannot compete with sagebrush, with Engelmann

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[1] Fetherolf, James M.: "Aspen as a Permanent Forest Type." Journal of Forestry, 15, 757–760, October, 1917.

[2] Sampson, A. W.: "The Stability of Aspen as a Type." *Proceedings of the Society of American Foresters.* Vol. 11, 86, January, 1916.

[3] Clements, Frederic E.: "Plant Succession." Pub. 242, p. 105, Carnegie Institution, Washington, 1916.

[4] "Instructions for Making Timber Surveys in the National Forests." Forest Service, U. S. Department of Agriculture, 1917.

spruce or lodgepole pine, even though fires are prevalent." If such is the case, the tree is of course truly permanent.

The position of the aspen in relation to the other types found on the mountains of the Great Basin is given in the article, as it appears typically on Boulder Mountain, in the Powell Forest, between the aspen and alpine fir mixed and the yellow pine or oakbrush type. It will be noted that no mention is made of a Douglas fir-white fir type in this list. This widely recognized type also occurs between the lower part of the Engelmann spruce-alpine fir type, designated in the list referred to as the aspen and alpine fir mixed type, and the yellow pine or oakbrush type. On Boulder Mountain the Douglas fir-white fir type is entirely lacking, however, its place being taken by pure aspen. In fact, in the greater part of the Great Basin region the lowest extremities of this belt are as a rule nearly pure aspen.

Nevertheless, there is ample evidence that this condition cannot be accounted for by any unsuitability of the sites, but rather by the lack of seed trees, as repeated fires have eliminated the conifers adapted to these sites. Indeed, on parts of the Powell National Forest not far from Boulder Mountain, as along the Winder-Escalante road, aspen is an exceedingly rare species and much less does it appear in pure stands. The road referred to is in the aspen and alpine fir mixed type where it crosses the divide, below which it passes into an open type of Douglas fir, with western yellow pines on drier and warmer situations and some aspen scattered throughout. Below is the pure western yellow pine associated with oak.

That both Douglas fir and white fir are able to grow in the belt between alpine conifers and the western yellow pine-oakbrush type is apparent in all parts of the region. Douglas fir is associated even with piñon-juniper below the yellow pine-oakbrush type in places, as on the south edge of the Manti Forest, in the canyon of the East Fork of the Sevier River, in the vicinity of Birch and Escalante creeks, on the Powell Forest, and in the neighborhood of the Utah Experiment Station. In the last locality white fir also is found scatteringly in many parts of the oakbrush zone. At its upper limits Douglas fir penetrates well into the spruce-fir type, although white fir stops rather abruptly at the lower limits of Engelmann spruce. The whole "permanent" aspen belt therefore seems entirely suited climatically to these two conifers.

A concrete example of this suitability is shown in Gooseberry Valley, which has been pointed out as a typical permanent stand, the aspen covering a large valley in absolute purity. Over a ridge to the north lies a parallel valley, similar to Gooseberry Valley as to slope, exposure, and elevation, but with a very slightly rougher topography. Upon a few rocky outcrops stand groups of white fir and Douglas fir seed trees, around which in the aspen thrifty reproduction is coming in. The reason for the "permanence" of the Gooseberry Valley aspen is apparently due merely to the complete elimination of all seed trees.

The proposition that, owing to the vigor of sprout reproduction and the density of the resulting stands, the aspen is able to choke out the conifers and thus maintain its supremacy, does not appear to be sound, even in the Great Basin. Clements[5] in discussing western tree species places aspen higher even than western yellow pine in a list of trees arranged in the order of their tolerance. Suppression of conifers by aspen has never been observed by the present writer. On the other hand there are a great many examples of conifers doing well under dense aspen shade.

On the clear cut plot at the Experiment Station to which reference is made in the article upholding the permanence of aspen, there were a number of small conifers before cutting, alpine fir, blue spruce, and limber pine, all of which are in a thrifty condition at the present time in the jungle of 5-year-old sprouts. It also appears that the author of the article may have been misinformed when he states that when heavy stands of aspen at the Experiment Station are underplanted they have to be thinned. It is true that one heavy stand was thinned for experimental purposes, and that it resulted in a stimulated growth of the planted conifers, coupled, however, with a greater annual loss than in the unthinned portion. In dense stands the growth of native conifers is retarded, to be sure, but death from suppression is rare. The effect of aspen cover upon trees planted at the Experiment Station is shown in a number of cases below. Light intensities given were determinated with a Clements photometer, the values being based on full sunlight as 1.00.

Plantations Made in Spring of 1916

Light intensity	.10	.51
Species—	Per cent living, fall of 1917	
Western yellow pine	76	69
Douglas fir	60*a*	57
Norway spruce	81	44

a Moisture conditions much the best on thinned area.

[5] Clements, Frederic E.: "Plant Succession." Pub. 242, Carnegie Institution, Washington, 1916.

Plantations Made in Spring of 1913

Light intensity	.25	.30	.45	.60	1.00
Species—	Per cent living, fall of 1917				
Engelmann spruce	61	30	19	12	0

Plantations Made in Spring of 1917

Light intensity	.09	.25	.30	.46	1.00
Species—	Per cent living, fall of 1917				
Western yellow pine	73	78	81	67	50
Douglas fir	68	55	60	44	55
Norway spruce	93	84	67	55	35

It will be observed that with the exception of the intolerant western yellow pine, which does best under moderate shade, the greatest success is correlated with the greatest aspen shade. Nevertheless, on the part of the plantation where the light intensity is but .09 normal there are a number of western yellow pines and Douglas firs from an administrative planting made in 1909. The pines are spindling and poor, but they still make good growth. The Douglas firs, on the other hand, are thrifty. Since .09 full sunlight is practically the minimum intensity under aspen, it appears from plantings that tolerant conifers can not only exist, but can thrive under all aspen, as far as light may be concerned. This fact has been noted elsewhere than at the Utah Experiment Station. Pearson recommends aspen as an excellent nurse tree in the mountains of Arizona and New Mexico[6] under conditions similar to those found in the Great Basin.

The natural reproduction shows up much the same as the planted stock. In the dense aspen referred to above, natural white fir seedlings are found at the rate of 86 per acre, and all appear to be doing well. Another area covered with dense aspen showed 110 white fir and Douglas fir seedlings per acre, all of which are thrifty, yet the light intensity is only .105 of the full sunlight.

The tolerance of native conifers is also shown on a permanent sample plot in first-class immature aspen. Here the aspen grew .38 inch in diameter between 1910 and 1915, while 20 alpine fir poles increased 1.69 inches. This indicates a condition far from suppression. The difference in height growth doubtless would be even more striking if the data were available. Nine per cent of the aspen on this plot died from crowding during the last 5-year period, but all the alpine firs remained healthy. It seems perfectly obvious, therefore, that aspen is quite unable to withstand coniferous invasion.

[6] Pearson, G. A.: "The Rôle of Aspen in the Reforestation of Mountain Burns in Arizona and New Mexico." *Plant World*, Vol. 17, 249, September, 1914.

The matter of the relations between aspen litter and the fungi. *Botrytis* and *Herpotrichia*, appears to have little weight. The more permanent aspects of aspen are most noticeable at lower elevations, although these diseases are most virulent at high elevations. Alpine fir is susceptible to this disease, and the blackened matted leaves are no infrequent sight, yet alpine fir admittedly is a vigorous invader of aspen stands. On Douglas fir and white fir the evidences of *Herpotrichia* are very rarely seen and accordingly these species should be

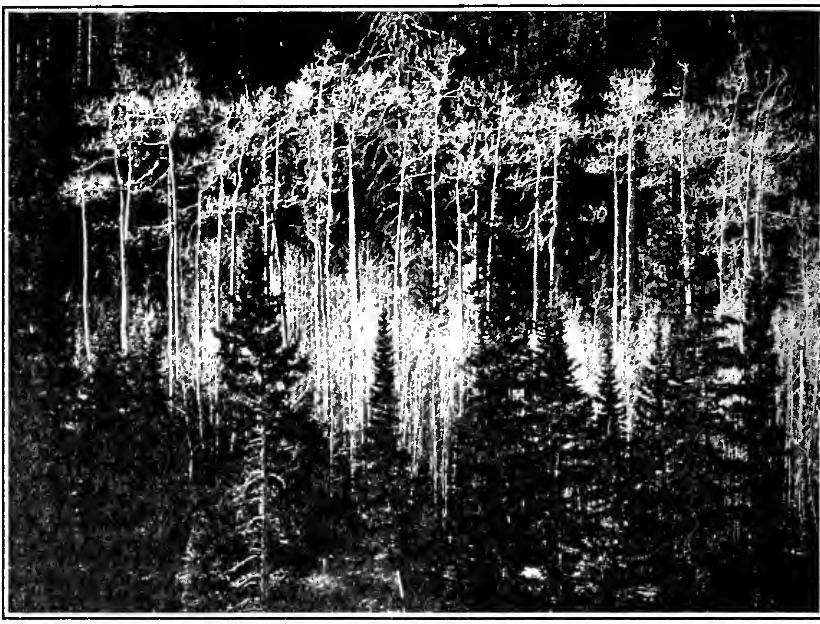

FIG. 1.—Typical two-aged stand. Manti National Forest.

even more safe under aspen than alpine fir is. The writer does not deny the possibility of destruction of young trees through the agency of these fungi, but he has never seen an example of it personally and does not believe the disease a formidable agent of destruction.

A plantation of Douglas fir made in the fall of 1916 under dense aspen was found practically all dead the following spring, with the leaves covered with a light gray cobwebby fungus, but planted Douglas firs which had been established several years stood among the dead ones entirely undamaged. On this account, as well as the fact that the fungus was growing densely upon some cut juniper branches and manure near by, it seemed more likely that the fungus is secondary and only attacks trees that were seriously weakened or already dead. Many failures of plantations thus ascribed to "snow fungi" associated with aspen leaves may not be due primarily to this at all. Their ability to attack natural reproduction is negligible in any case.

In regard to rabbits, conditions are much the same. Damage is undeniably great, particularly where the conifers are very scattering. Nevertheless, death rarely ensues from this cause. The trees are usually from two to four feet tall and well established during the time of greatest damage, and although the leader is removed year after year, the tree does not die, but spreads laterally and finally escapes and makes rapid development. On a permanent sample plot recently established, practically every white fir seedling about two feet in height showed rabbit injury, yet not a dead tree was found on the area. Rabbit injury to plantations is very frequent and heavy. Nevertheless, a study of the rabbit damage on the yellow pine planting of 1915 showed 59 per cent of the uninjured trees living, against 55 per cent of the trees damaged by rabbits—an insignificant difference of 4 per cent. It appears, therefore, that as a cause of mortality, rabbits are not very powerful. At most they could only be recognized as slowing down the succession and thus making the subclimax stage somewhat more persistent.

Accordingly, therefore, there is no evidence that aspen, either of itself or by means of associated fungi and biotic factors ,is able in any case to withstand an invasion by white fir or Douglas fir in the so-called "permanent" aspen belt.

If aspen is to be regarded as temporary its present prominence in such pure stands over large areas must be accounted for by repeated fires in the past, which have eliminated the conifers, but have favored the aspen, which reproduces by sprouts. The point which has been raised in defense of permanence, that aspen is negligible as a type in the forests of Idaho, where fires are as frequent as they are in the Great Basin forests, and therefore that its permanent aspects in the Great Basin are independent of fire agencies, does not take into account the fact that the Idaho forests are within the range of lodgepole pine, which replaces aspen there, since it holds a similar ecological position in relation to fires.

The fact that the fires have been very numerous in Great Basin aspen stands in the past may be definitely proven. Charcoal is abundant in every soil under aspen cover; sometimes it is from conifers, but usually from aspen. Even-aged stands are frequent. Striking two-aged stands are also often seen. The one shown in figure 1 shows clearly the fire origin of the stand, as the old trees are cat-faced, butt-scarred, and occasionally show charring. Many other two-aged stands have been investigated and they uniformly show the same conditions. Of course, many old aspen stands exist where no fires have run for a long time, which assume a broken, uneven-aged form. The most "permanent" stands, namely, stands with no coniferous admixture, are very likely to be even-aged, however, showing clearly their fire origin. Since fires almost never run through aspen at the present time, it may appear dif-

Fig. 2.—Heavy grass cover in aspen stand under light grazing

ficult to believe that they were frequent not more than 50 years ago. It has not been long since the aspen areas were covered with a dense growth of tall grasses (*Bromus* and *Agropyron*), however, such as may still be found in a few areas inaccessible to stock or where stock is excluded, as in figure 2. These grasses grow the best on the deep rich soils of the aspen belt and in moderate shade. Upon rocky outcrops they become sparse and short, and in the deep coniferous shade, as on north slopes, they are absent or fail to develop well. Such grasses form a great mass of inflammable litter that would burn rapidly, killing the young conifers and all or most of the easily injured aspens, thus giving rise to even-aged or two-aged stands. Moderate barriers that would interrupt the continuity of the dense grass, however, would stop them. Thus we find open groups of old conifers on rocky knolls and frequent stands of white fir and Douglas fir on north slopes all through the "permanent" aspen belt. However, it is not intended to convey the idea that the latter are not subject to fires. They have probably not been subject to the recurrent grass fires, but have been burned severely at more infrequent intervals, since on north slopes coniferous reproduction is most vigorous and has much the best chance of eliminating the only moderately tolerant grasses.

Grazing and protection are the two great factors of the present time which have eliminated the fires and thus broken up the apparent stability of aspen. Everywhere in the presence of seed trees reproduction is rapidly coming in. It is useless to expect the impossible, however, and to find a vigorous invasion of conifers far from seed trees, particularly against the prevailing winds. Thus it is that many areas such as those cited by Fetherolf as typical of the permanent aspen must remain without conifers for a long time yet, for in such places as Joe's Valley on the Manti Forest and Gooseberry Valley on the Fishlake National Forest repeated fires must have run without obstruction through miles of uninterrupted grass, till not a single conifer has been left. The slowness of the reseeding is evinced by figure 3, which shows the distribution of seedlings under aspen about isolated white fir seed trees (1) in the case of a tree exposed to moderate winds from all directions, and (2) in the case of a tree exposed to strong west winds only. Everywhere within the seeding limits of the trees the reproduction is vigorous and ample. On a permanent sample plot located in aspen near a body of white fir and Douglas fir, well below the limits of alpine fir, and therefore in the general "permanent" aspen belt, there are 4,182 seedlings and saplings per acre. On the end farthest from seed trees, about 150 feet distant, they run 2,178 per acre, and on the other and 60 feet distant there are 67,518 per acre. As the ability of these conifers to crowd out aspen as a type is undoubted, although individual trees are bound to persist in almost coniferous stand, it is very evident that this aspen is far from permanent. Similar data have been secured in many other places in the aspen stand and all lead to one conclusion: The aspen is essentially temporary, although the seeding in of large areas by conifers is a very slow process.

As Fetherolf[1] remarks, a proper knowledge of the permanence of aspen is necessary to the proper management of the type. If from an

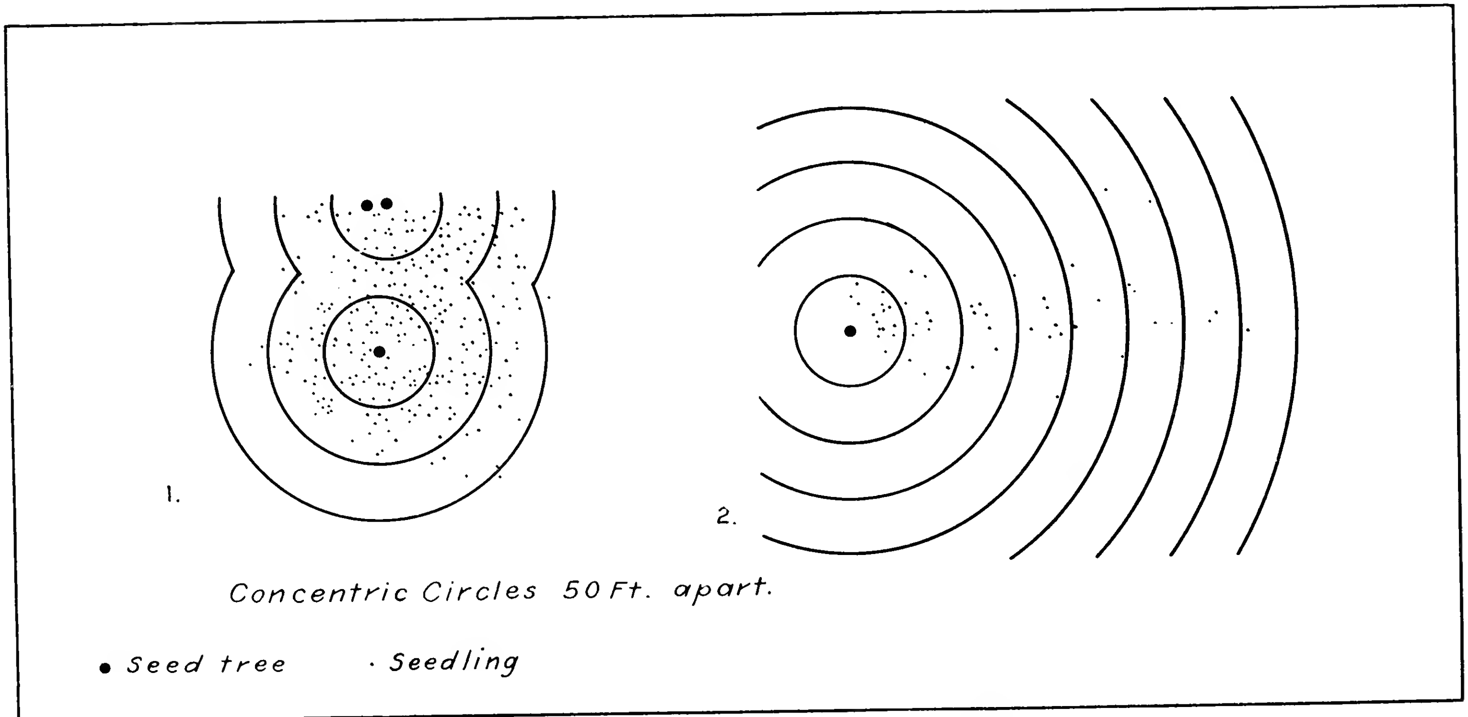

FIG. 3.—Distribution of seedlings in relation to seed trees

economic viewpoint the tendency toward a reversion to conifers is desirable, management must be so applied as to favor them by moderate cuttings to maintain an optimum sheltering canopy rather than a clean cutting system that is so favorable to aspen, but which is not conducive to the establishment of the conifers. Planting under aspen is an entirely natural process and will undoubtedly prove successful with Douglas fir when the methods of handling that rather difficult species are properly worked out. While it is impossible at this time to state whether the perpetuation of the aspen type or its reversion to coniferous forest is most desirable from the standpoint of forest management, it seems probable that at least the poorer aspen sites will be turned over to the conifers, as they alone yield material which is merchantable at the present time on such sites. Since aspen is so clearly temporary, such a change can be made either by assisting natural tendencies or by artificial means with no fear of ultimate failure; for whatever the economic relations of the aspen and conifers (white fir and Douglas fir in particular) may be, their ecological relation is unmistakable and is essentially the same here as elsewhere throughout the range of aspen.

ACCELERATED GROWTH OF BALSAM FIR IN THE ADIRONDACKS

By E. F. McCarthy

Professor of Forest Utilization, N. Y. State College of Forestry

This study of growth was made following a pulp logging operation in northwestern Hamilton County, near Brandreth Lake, N. Y. The unusual growth of the stand was not discovered until the age classes were computed separately. Diameter growth curves show that each of the age classes was released from suppression about 50 years ago, or possibly half a decade sooner than that.

While the cause and knowledge of the exact time of the release would open the way to new determinations, facts are evident which show new possibilities of balsam pulp-wood production. The suggestion is made that the cause of release was the cutting of a stand of pine which had been sufficiently dense to hold the balsam in suppression.

Measurements were taken on trees cut along the west side of the inlet to Rose pond. The type was characteristically swamp, located on flat bench-lands back from the small stream that drains the valley. The valley itself has a slight slope, but the forest floor is of the spongy, sphagnum type characteristic of true swamps, and the stand of timber of pure balsam-spruce. While there is a distinct drainage to the small valley, the areas from which measurements were taken were swampy, flat benches. The site might have supported a stand of white pine at some time past. The valley opens to the southwest and is flanked on both sides by ridges with a mixed spruce-hardwood cover. The upland was cut for spruce to a diameter limit 20 years ago, but the lowland was not logged, nor was the hemlock on the upland cut.

Field work was carried on in September, following the cutting and peeling of the balsam, but before the trees had been cut up into log lengths. The trees lay where they had fallen, with the tops lopped and cut off at the 4-inch diameter. Decade measurements were made on the stump, counted in and measured out from the center. Record was also made of the total height, merchantable height, crown length, stump height, diameter at breast height inside bark, and a ring count and measurement at the point of cutting in the top. All trees that were cut were taken, except those that were cut with an ax, which were few and small, and those that were decayed at the center on the stump, which were usually large, but amounted to less than 5 per cent of the total. Average measurements were made on all diameters.

The trees were for computation separated into age classes and decade measurements were mathematically averaged. (The fallacy of this

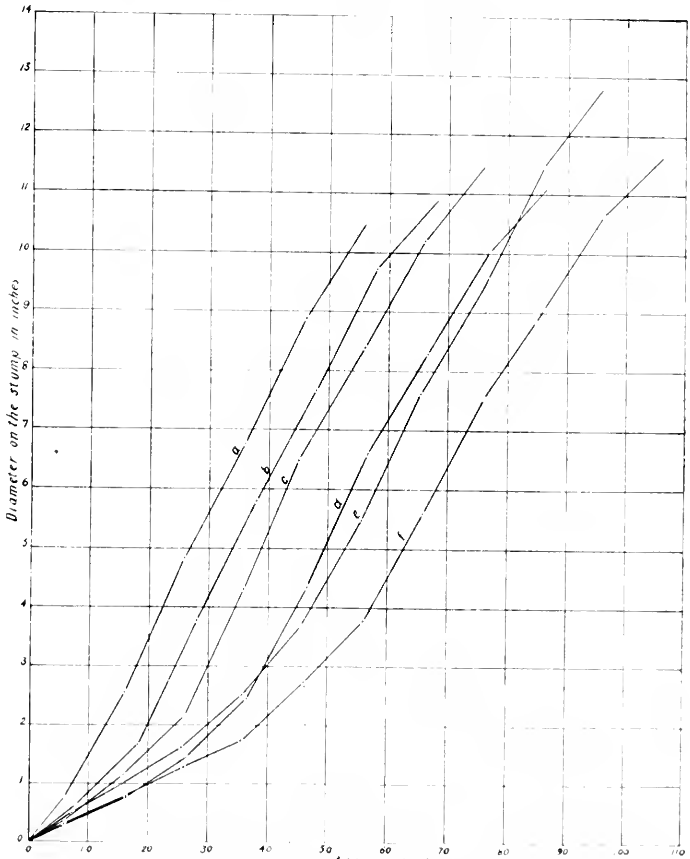

FIG. 1.—Diameter growth on the stump for balsam fir, by age classes, from 208 trees taken on swampy-bench land, Brandreth Lake, N. Y.:

(*a*) 50– 60 year age class.
(*b*) 60– 70 year age class.
(*c*) 70– 80 year age class.
(*d*) 80– 90 year age class.
(*e*) 90–100 year age class.
(*f*) 100–110 year age class.

method is more than counterbalanced by the advantages in this case.) Results were plotted for comparison only, and the curves have not been varied from the points mathematically determined.

The following facts may be noted from the diameter growth curves:

1. At a period five decades back from the time of cutting all age classes began an accelerated growth.
2. The largest—that is, the oldest—age class at that time was 3.8 inches on the stump.
3. The younger trees responded more quickly and grew more rapidly than the older.
4. The youngest age class passed through no period of suppression, and was cut for pulp 56 years after it passed the stump height.
5. All age classes show a crowding in the last decade.

Comparisons of the results shown in Table 2 serve to emphasize the comparatively equal development of stem in all age classes and show a larger number of trees in the 60–70 year class than in any other.

The average age of all the trees 50 years ago was 27 years, and the average diameter on the stump for that age 2.16 inches. The average diameter of all trees at the time of cutting was 11.16 inches on the stump, and the average age at that time 77 years.

No complete caliper record was obtained, since the true significance of the stand was not known at the time the measurements were made. It is still possible to obtain such a record from the stumps, and so obtain yield and an idea of the condition of the cut-over area.

This study is sufficient basis for the assertion that a crop of balsam fir, merchantable in the present interpretation of the word, can be produced in 60 years from seedlings. It must be pointed out also that the stand does not show crowding until the last decade, and for this reason would not need thinning during this period of production. No statement can now be made as to the probable loss of trees from the stand during the last 50 years' growth.

TABLE 1.—*Dimensions of 208 Trees (Balsam Fir) not Averaged by a Curve*

Diameter breast height outside bark, inches.[1]	Total height, feet.	Average age, years, above the stump.	Volume in cubic feet, total.
9.63	62.7	56	15.84
9.75	63	68	16.30
10.2	64	76	17.96
9.85	64	87	16.90
10.4	64	96	18.60
9.8	64	106	16.70

[1] Bark thickness was taken as .6 inch from U. S. Dept. Agr. Bul. 55. Volume was interpolated from volume table 19, in same bulletin.

TABLE 2

Age class and average age.	Merch. height, feet.	Total height, feet.	Crown length, feet.	D. b. h. ib., inches.	Stump height, inches	Number of trees in class.
50– 60 } 56	46.7	62.7	31	9.03	11.7	22
60– 70 } 68	47.7	63	31.6	9.15	11	70
70– 80 } 76	48	64	33.4	9.6	12.2	38
80– 90 } 87	47	64	31.3	9.25	11.4	40
90–100 } 96	50	64	34.4	9.8	12.4	30
100–110 } 106	47.7	64	32.4	9.2	13.6	8
Total..........	....	....	....	....	....	208

TABLE 3.—*Stump Diameter Growth Table for Balsam*

208 trees. Mathematical averages—not curved

Age class	Diameter in inches by decades									
	1	2	3	4	5	6	7	8	9	10	11
50– 60..	.78	2.56	4.64	6.76	8.88	10.48	.....	.....	.....	.....	.....
60– 70..	.64	1.64	3.76	5.8	7.68	9.74	10.88	.....	.....	.....	.....
70– 80..	.36	1.18	2.16	4.32	6.50	8.40	10.20	11.48	.....	.....	.....
80– 90..	.35	.81	1.40	2.42	4.30	6.60	8.28	10.00	11.10	.....	.....
90–100..	.40	1.00	1.52	2.52	3.70	5.46	7.62	9.36	11.40	12.8	.....
100–110..	.32	.78	1.30	1.75	2.72	3.80	5.60	7.56	9.06	10.64	11.64

FIRST SEASON'S GROWTH AND MORTALITY OF WHITE-PINE AND RED-PINE PLANTATIONS

By Cedric H. Guise

Department of Forestry, Cornell University

The principal aims of this study were to find the relative rates of height growth and root development and the mortality, during the first season of planting, with various grades of red-pine and white-pine nursery stock; and, furthermore, to ascertain the immediate effect of temperature and rainfall on growth and mortality.

The greater part of the work was conducted at the Behrends Farm, an experimental area of the Department of Forestry, New York State College of Agriculture, at Cornell University. Each experimental plot is 100 feet square.

Another excellent opportunity for studying mortality in actual plantations of red pine and white pine was available in the plantations made by the Department of Forestry on the slopes of a proposed reservoir site of the University, near Varna, New York. Counts were made in these plantations and the results incorporated in this article.

HEIGHT GROWTH AND ROOT DEVELOPMENT

Planting Site

The experimental plots all lie on a flat bench surrounded by low, rolling hills. At the time of planting these were covered with a layer of sod from three to five inches thick. There was no other ground cover nor underbrush. The soil is a Dunkirk gravelly loam, dark brown in color, with stones and pebbles of all sizes, but generally less than three inches in diameter, freely interspersed. It is well drained and easily worked.

Stock

The stock used in planting was of two species—white pine and red pine. Both three-year and four-year transplants of white pine were used, but only three-year transplants of red pine. All of this stock came from the forest nursery of the Department of Forestry, and in every case had been in seed beds for two years before transplanting.

The two-year seedlings were obtained from the New York State Conservation Commission.

Grades

The four-year transplants of white pine were divided into three grades—called A, B, and C—according to size and quality. The arbitrary basis for grading this stock was principally by size, though due allowance was made for its physical condition. The sizes of the grades and the ranges of root lengths corresponding to these heights are as follows:

Grade	Height Inches	Root length Inches
A	over 8	14 –23
B	5–8	11.5–16
C	under 5	9 –13

In grading the three-year red pines only two classes were distinguished. Grade A included those of four inches and over in height and the most thrifty in condition. Grade B included all others whose height at that time was less than four inches or in a less thrifty condition than Grade A, though almost as tall. The root lengths of Grade A varied between six and ten inches. In Grade B the trees were generally between five and eight inches in root length.

Only one grade of 2–1 stock[1] of white pine was planted; this stock was all poor and scarcely justified a division into grades. Most of this stock had suffered from delay in transplanting in 1914 on account of weather and soil conditions and came from transplant rows which in every case showed a heavy mortality. The average height of these trees was close to five inches, with a root length averaging from five to seven inches.

Care of Stock

On April 12 the four-year-old white pines and the three-year-old red pines were removed from the transplant rows, graded and heeled in at the nursery. They remained there until the morning of April 14, when they were carefully packed for transportation to the site of the experimental plots. At this place they were again heeled in until set out in the plots. Two days later, April 16, Grades A and B of the 2–2 white-pine stock were planted. On April 17 Grade C of the white pine and A and B of the red pine were planted.

The 2–1 white pines were dug and heeled in at the nursery on April

[1] 2-1 stock, two years in seedbed, one year in transplant rows. 2-2 stock, two years in seedbed and two years in transplant rows.

TABLE I.—*Height Growth of Graded White Pine and Red Pine Nursery Stock by Weeks*

[All figures in inches]

Stock	Grades	No. of trees	Height growth by weeks													
			May 1	May 6	May 14	May 21	May 28	June 4	June 11	June 18	June 25	July 2	July 9	July 16	July 23	July 30
White pine, 2-2	A	77	.70	.91	1.44	1.66	2.09	2.56	3.66	4.82	5.36	5.91	6.42	6.69	6.89	7.01
	B	148	.61	.76	1.18	1.35	1.70	2.00	2.88	3.76	4.37	4.76	5.10	5.31	5.43	5.56
	C	145	.53	.61	.95	1.06	1.42	1.59	1.93	2.34	2.75	2.95	3.30	3.37	3.42	3.46
White pine....	2–1	68	.30	.37	.43	.46	.55	.70	1.01	1.24	1.33	1.45	1.53	1.57	1.58	1.59
Red pine, 2-1..	A	138	.84	.93	1.30	1.50	1.83	2.04	2.32	2.63	2.88	3.63	3.70	3.76	3.79	3.80
	B	143	.51	.57	.78	.92	1.18	1.41	1.68	1.99	2.17	2.42	2.70	2.84	2.92	2.95

20 and packed the following day. This stock remained in the hampers until the 24th, when it was carried to the experimental plots and planted.

All trees were carefully set out by the hole method after a layer of sod approximately 18 inches square had been removed. They were spaced six feet by six feet. The soil was moist, easily worked, and in excellent condition for planting.

Record of Measurements

The records of height growth for the current season were taken every week, starting May 1. On each plot 50 per cent of the trees were measured, the same trees being measured each successive time. For the trees of each plot the average growth was obtained by adding the total growth and dividing by the number of trees measured. Table 1 shows the average height growth of each grade of each species by weeks. There were approximately 140 trees measured on each plot. Root development was ascertained by selecting for each grade several trees of average height growth, then carefully removing and measuring them. This was done after growth had ceased, and hence no data of weekly root growth can be presented.

Grass and weeds had no mechanical effect on the growing stock during the growing period.

Table 2 shows the root lengths of each class before and after planting

TABLE 2

[Based on two average trees of each grade]

Stock.		Length of roots. At start of growth.	Length of roots. At end of growth.	Remarks.
		(Inches)	*(Inches)*	
2-2 white pine	A	14 –23	19 –28	Roots thickened and in a compact mass for ten inches.
	B	11.5–16	14 –19.5	Same as with A.
	C	9 –13	11.5–17	Bunching and thickening not so prominent.
2-1 white pine.....		5 – 7	8 – 9.5	Growth only fair.
2-1 red pine...	A	6 –10	8 –11.5	Growth more uniform than with white pine. Thickening and bunching not so noticeable.
	B	6 – 8	7 –10.5	

Temperature and rainfall are of paramount importance in controlling the growth of plants. The daily records of each of these were ob-

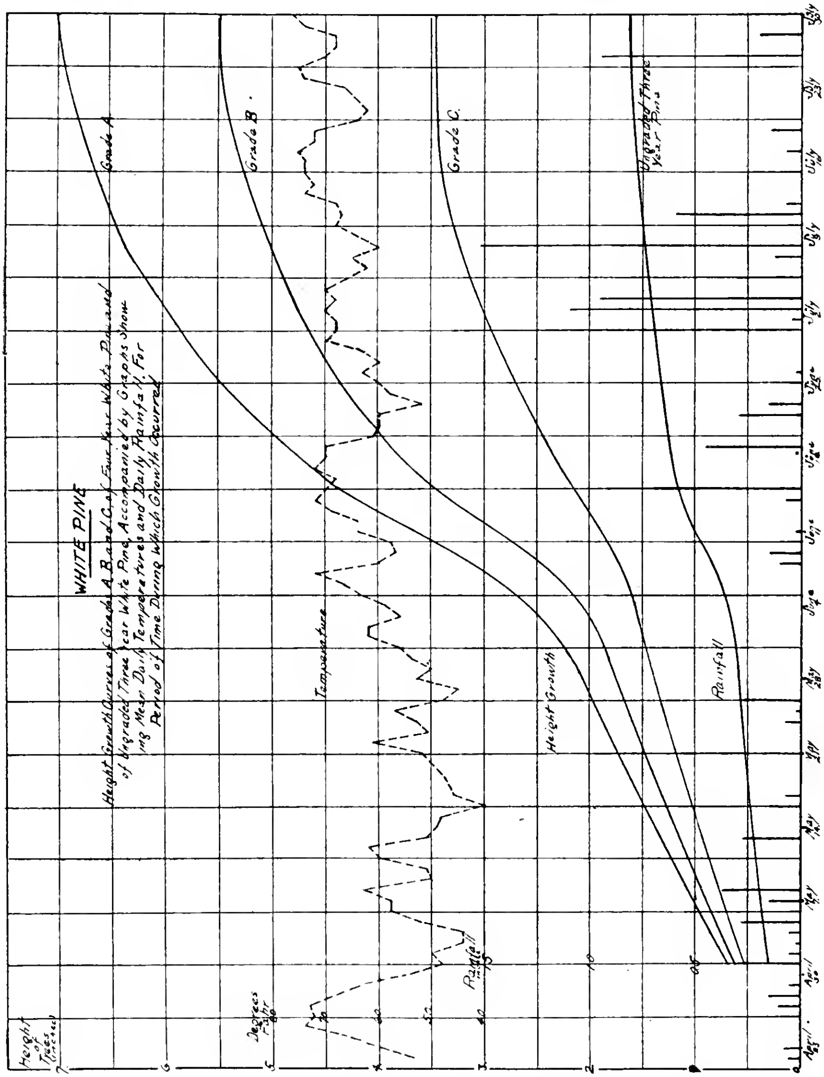

FIG. 1

tained from the station of the U. S. Weather Bureau at Ithaca and are shown graphically.

To show the relation existing between temperature and rainfall and the height growth of the grades of young trees, the accompanying curves and graphs are presented (figures 1 and 2).

The temperature plotted is the mean between the maximum and the minimum for each day.

Inspection of the growth curves will show that the greatest height

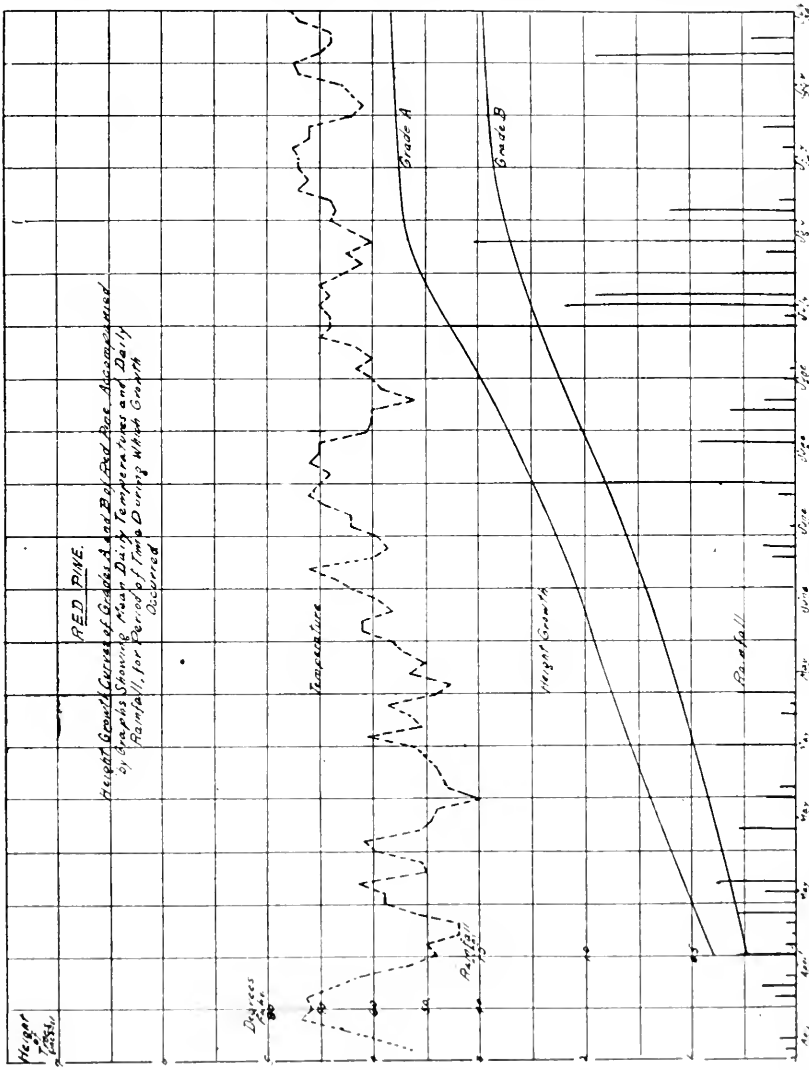

FIG. 2

growth is obtained by the largest stock, both in the case of white pine and of red pine.

Each grade of the four-old-year white pines and the three year-old red pines has its period of greatest height growth beginning about June

1 and concluding during the week of July 2 to July 9. An exception occurs in the case of the three-year white pines. The period of greatest height growth for this grade ceased close to June 18.

After the period of maximum height growth has ceased in the case of the four-year white pines and red pines, this growth still continues to some extent. However, the growth occurring after the middle of July was in all probability not in the length of the terminal shoot, but in the elongation of the needles. This is more prominent in the case of the four-year white pines than with the red pines. With the latter there is scarcely any increase, even in the length of the needles, after the middle of July.

The temperature and rainfall of the season of 1915 were exceedingly favorable for growth.

Tables 3 and 4 show for the last five years, for the months of April, May, June, and July, the rainfall and the mean temperatures. The normal values are for the last 25 years.

TABLE 3.—*Rainfall*

Month	Precipitation in inches					Normal	Excess or deficiency for 1915 with normal
	1911	1912	1913	1914	1915		
April	2.05	2.97	1.49	4.35	0.55	2.99	—1.74
May	2.24	3.58	3.15	3.63	2.44	3.43	—0.99
June	3.59	1.37	2.00	4.75	3.94	3.88	+0.06
July	2.53	2.64	1.59	1.89	6.18	3.75	+2.43

TABLE 4.—*Temperature*

Month	Temperature in degrees Fahr.					Normal	Excess or deficiency for 1915 with normal
	1911	1912	1913	1914	1915		
April	44	44	48	42	51	44.2	+7.0
May	64	58	55	59	52	57.0	—5.4
June	66	63	65	66	64	66.2	—2.6
July	73	71	70	70	69	70.6	—1.4

The rainfall in 1915 exceeded the normal in every month except May. The data shows a deficiency for April. But .43 inch of the total .55 inch fell after the 16th, when the planting was done. This gave particularly favorable conditions for the stock to establish itself.

Although the rainfall during May was one inch below normal, nevertheless the amount was well distributed and was sufficient for good growth, and there was no time at which a scarcity of moisture was felt. There was sufficient to start the stock on its period of maximum rate of height growth, which continued through June and into the first of July. From this study, results show that this period occurs during June, and there was at no time so little moisture as to retard it.

The greater part of the precipitation in June came during the latter part, and no doubt is the direct cause for the continuance of height growth to the middle of July, whereas it ordinarily ceases early in the month.

Investigations by H. P. Brown[2] (1912-1913) of the growth of white pine show very similar results, though the period of height growth terminates sooner than in the case of the trees for the season of 1915. The conclusions derived from those investigations are, first, that the cessation of growth in the length of shoots of white pine occurs during the early part of July, and, second, that the elongation of the leaves does not cease until around the middle of August.

The longer period during which height growth occurred during 1915 is no doubt directly due to the abundant rainfall of this season. Although the rainfall throughout July was exceedingly heavy, the inherent qualities of the stock cause the height growth to fall off and later cease, regardless of the amount of rain.

The temperature was below normal except for April. For this month it was seven degrees Fahrenheit above normal, and with adequate moisture was extremely favorable for the establishment and development of the planted stock. While the temperature was below normal for the other three months, there were no protracted periods of cold weather, and the range was much above that necessary for the growth of the young pines. The few degrees registered under normal for May, June, and July have had, apparently, a negligible effect, so far as retarding height growth.

In conclusion, the uniformity of the periods of height growth of all grades of healthy stock of both species shows clearly the extent to which temperature and rainfall influence this growth.

Very little can be proved with the three-year white pines, since their physical condition when planted was so poor that such conclusions cannot be drawn.

When rainfall and temperature are close to normal during the growing season, good height growth of young pines will take place in this locality. Heavy rainfall has a more pronounced effect than high temperature, and is of particular influence in prolonging the growth of pine transplants beyond its normal period of height growth. However, conclusions from this study would show that growth of the leading shoot will cease around the middle of July, no matter how abundant the rain-

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[2] Brown, H. P., 1914: "Growth Studies of Forest Trees—*Pinus strobus*." Thesis for Degree of Doctor of Philosophy in Botany, Cornell University, 1914. (Unpublished.)

TABLE 5.—*Loss in Various Grades of White Pine and Red Pine by Weeks*

Species	No. planted	Number of deaths by weeks: May 1	May 6	May 14	May 21	May 28	June 4	June 11	June 18	June 25	July 2	July 9	July 16	July 23	July 30	Aug. 6	Total No. dead	Per cent living
2-2 white pine { A	153	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
2-2 white pine { B	293	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
2-2 white pine { C	289	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	5	98.3
2-1 white pine	136	1	0	5	25	26	2	0	0	0	0	0	0	0	0	1	60	56
2-1 red pine { A	277	0	0	1	0	1	1	1	0	2	1	0	1	0	0	0	8	97.1
2-1 red pine { B	285	9	1	1	0	9	3	2	2	5	1	0	0	2	0	1	35	87.8

fall; also that the better the grade of stock the greater is the height growth and root development.

Mortality

Counts for the mortality during the first season of plantations of graded nursery stock were made weekly at the experimental plots of the grades of white pine and red pine described previously.

While growth measurements were made only on 50 per cent of the trees, the mortality counts included every tree. These were made on the same dates that the measurements were taken.

Table 5 shows by weeks the loss in each grade of each species, the total number dead, and the per cent living.

Results here are of exactly the same nature as with the height growth, the better the grade of stock planted the more satisfactory are the results. The absence of mortality in grades A and B and the mortality of less than 2 per cent with grade C of the four-year white pines show how successful planting can be carried on during a favorable growing season if careful treatment is given the stock. In contrast the high mortality—46 per cent—of the three-year white pines shows what may be expected from stock which is not well cared for at all stages of nursery practice. The death of many of these trees is directly traceable to the delay in transplanting in 1914 and in the treatment incident to planting in 1915.

Grade A of the red pines was unusually thrifty and the low mortality is not unexpected. Grade B shows that, as with white pine, the better the grade of stock the lower the mortality. With justice to this grade, it should be said that the ground cover was more dense and troublesome on this than on any other plot and has probably as much effect as the grading on mortality. Even with this, however, the experiment shows that during the first season plantations of red-pine and white-pine stock of higher grades will be less affected by mortality than will those of lower grades of the same stock.

Mortality counts were also made biweekly on plantations of red pines and white pines located about four miles north of Ithaca. The soil is a dark Dunkirk clay loam, almost free from stones and easily worked. The land planted is almost flat and well drained. Thirty-six thousand trees were set out, there being an equal number of red pines and white pines in mixture. A layer of sod covered the fields (this was formerly pasture and hay land).

Temperature and precipitation records can be ascertained from the graphs shown previously.

Stock

Both the white pines and red pines were 2–2 stock and were obtained from the State nurseries. The white pines came from the Salamanca Nursery, arriving at Ithaca on April 14. These remained in the hampers until the morning of the 16th, when they were transported to the planting site and heeled in.

The red pines came from the Comstock Nursery, arriving at Ithaca on the 15th, and on this and the following day were taken to the planting site and heeled in.

Planting started immediately and was carried on for two weeks, when all the stock was set out. Excellent weather conditions prevailed at all times and the soil was in splendid shape for planting. In every case a layer of sod was stripped off and the trees planted by the hole method. Counts were made every two weeks and covered 984 trees, or 2.73 per cent of this season's planting.

Table 6 shows the biweekly record of the mortality counts.

TABLE 6.—*Number of Deaths by Date*

	Species	
	White pine	Red pine
Number of deaths by date:		
May 7	11	4
May 25	3	3
June 4	1	6
June 20	1	1
July 2	1	2
July 16	0	2
July 30	0	2
August 13	0	0
Total number dead	17	20
Estimate of per cent living	96.3	95.7
Mortality	3.7	4.3

Stock planted in 1913 on adjoining sites shows a mortality of 14 per cent. However, 1913 was an extremely dry season and the high mortality, as compared with that of stock planted in 1915, can be directly traced to this.

To expect as low a mortality as shown for this year's planting is perhaps too much. Nevertheless, it shows what is possible, under favorable weather conditions, with four-year-old ungraded commercial nursery stock of white pines and red pines.

THE RELATION OF GERMINATION IN THE GREENHOUSE AND NURSERY

By S. B. Show

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After all questions of nursery practice are settled, after the correct source of seed is determined, after the desired output of the nursery is set, the best-laid plans will gae aglee if the amount of seed sown is improperly gauged. It is therefore essential that each lot of seed should be properly tested; that the test results should be co-ordinated with actual germination in the nursery, and finally that the nurseryman should follow the indicated figures rather than his own individual hunch.

Seed-testing in the greenhouse is done under fairly well-controlled conditions, which vary only slightly from year to year. These conditions are, however, artificially created and do not correspond to conditions in the nursery, which cannot be controlled and which vary from year to year decidedly. It follows, therefore, that results of greenhouse tests cannot be applied directly to field sowing, and that certain corrections must be made before they are usable.

The factors influencing both rapidity and total amount of germination of a given lot of seed are:

1. Temperature of soil.
2. Character of soil.
3. Amount of light.
4. Amount of water.
5. Depth of cover.

Various investigators have shown that, with other factors constant, each of these influences has a very marked effect on the germination of a given lot of seed. The last three factors can be pretty well standardized, both in the greenhouse and nursery. The character of soil is predetermined, except as changed by fertilizing; temperature is consequently the variable.

THE SOIL FACTOR

In so far as this district is concerned, four distinct soils are to be considered, as follows:

1. River sand, used in greenhouse tests.
2. Clay, modified by screening and the addition of 10 to 15 per cent (by volume) of river sand, used in the Feather River Nursery.
3. A light, loose, porous volcanic soil, roughly classified as volcanic ash, at Pilgrim Creek Nursery.
   (*a*) Modified by addition of sheep manure and burnt lime.
   (*b*) In virgin condition, except for plowing and cultivation.

In order to determine the effect of character of soil on rapidity and completeness of germination, tests in each of the above soils were made in the greenhouse during the winter of 1916-17. Yellow pine with one test, Jeffrey pine with two, and incense cedar with one test were used. More elaborate comparison was impossible with the small amount of Pilgrim Creek soil which was available, and the expense of shipping it was too great to justify further importations. At any rate, the results, while certainly not the last word on the subject, represent a step in advance toward the ultimate solution of the seed-testing problem and may be accepted at face value pending further work.

Results are shown in Table 1:

TABLE 1.—*Comparative Germination in Different Soils*

Species	Kind of soil	Germination—Days				
		20	40	60	80	100
Yellow pine......	Ash, unfertilized.......	0	28.0	58.0	64.0	....
	Ash, fertilized.........	0.5	19.5	61.5	64.0	....
	River sand............	0.0	16.0	55.0	60.0	....
	Clay	0.0	4.0	48.0	54.0	....
Jeffrey pine.....	Ash, unfertilized.......	0.0	23.0	55.5	63.0	....
	Ash, fertilized.........	0.0	28.0	66.0	69.0	....
	River sand............	0.5	11.5	62.0	69.5	....
	Clay	0.0	7.0	42.0	48.0	....
Incense cedar....	Ash, unfertilized.......	0.0	2.5	10.0	12.0	....
	Ash, fertilized.........	0.0	11.5	18.0	19.0	....
	River sand............	0.0	5.5	22.5	24.0	....
	Clay	0.0	2.0	13.0	18.0	....

Germination is possibly a trifle more rapid and complete in the fertilized Pilgrim Creek soil than in the unfertilized, which points to the desirability of the past practice at that nursery. For the pines the tests in sand (the greenhouse medium) are practically identical in rapidity and completeness with the fertilized ash, while for cedar sand gives the best results. Results of greenhouse tests can apparently be applied directly to the Pilgrim Creek conditions. Tests in clay are lower than any other and also slower for the pines, and check the conclusion previously reached that seed sown in the Feather River Nursery does not hold up to greenhouse values. The incense cedar in clay is lower than for sand, but exceeds the average of the tests in the ash soil.

TEMPERATURE

The effect of temperature on germination in general is easily described; but when an attempt is made to determine the specific effect of certain maxima, minima, and means on a certain species, difficulties are at once encountered, and it is clear that only laboratory experiments with exactly controlled conditions can really solve these questions. However, we can, with some certainty, go at the problem by using only the admittedly rough data at present available.

It is a common experience in greenhouse testing to find germination slow during cloudy weather, but rapid after clear, sunshiny days. Boerker and others seem to have shown that light itself not only does not increase either the speed or completeness of germination, but that germination is better in the absence of light. Evidently temperature is the controlling factor.

Mean temperature, while a convenient expression, does not apply strictly to a study of germination. An examination of greenhouse germination shows that after two days with the same mean the germination increases with increase between extremes. Thus if the temperature is constant at 60° F. on one day and varies from 50° to 70° F., with a mean of 60°, on another, the germination is highest following the latter.

The practice in testing seed in greenhouse is to hold air temperatures to a minimum of 50° F., in which case soil temperature will reach an average minimum of 55°, unless the air minimum is prolonged, when the two will be equal.

An examination of thermograph sheets and germination records indicates that minimum air temperatures down to 32° F., the freezing point, do not retard germination, and in fact appear to accelerate it unless prolonged.

Seed in the nurseries is, of course, subjected to a wider variation in temperature than in the greenhouse, but it is difficult to say that this results in slower germination. It is probable, though not proved, that the accumulated temperatures above 40° F. control germination.

VITALITY OF SEED

An important phase of forestation work is the age of the seed used. Many questions suggest themselves: How long will seed retain its vitality? What deterioration is there from year to year? Is it safe to use a test of one year to apply to sowing a year or two later? Should several years' supply be collected in an exceptionally good seed year, or should an attempt be made to secure fresh seed every year?

The following data are of interest in this connection:

The first two tables show separately for northern and southern California Jeffrey-pine seed the results of tests on seed of different ages. Though based on a small number of tests, it seems apparent that no serious loss in germinating power occurs up to the fourth year, and that seed several years old can safely be used.

TABLE 2.—*Jeffrey Pine—Effect of Age on Germination*

Northern California Seed

Age	C. T.	G.	N.	G. / C. T.	N. / C. T.	G. / N.	No.
New	79	65	63	82	77	94	6
1 year	75	63	61	83	82	98	4
2 years	77	66	74	86	96	116	2
3 years	76	52	57	69	75	..	1
4 years	80	80	73	100	91	..	1

TABLE 3.—*Jeffrey Pine—Effect of Age on Germination*

Southern California Seed

Age	C. T.	G.	N.	G. / C. T.	N. / C. T.	G. / N.	No
New	80	63	53	79	67	84	5
1 year	77	42	36	54	46	86	5
2 years	74	52	42	70	57	83	5
3 years	70	44	47	62	67	107	5
4 years	62	41	44	66	70	106	1

The next two tables show similar data for yellow pine:

TABLE 4.—*Yellow Pine—Effect of Age on Seed*

Northern California Seed

Age	C. T.	G., 120 days	N., 120 days	G. / C. T.	N. / C. T.	No.
New	77	64	64.5	83	83	3
1 year	86	72	71	84	83	4
2 years	81	75	68	92	84	5
3 years	90	60	56	67	62	6
4 years	..	..	..	..	..	..
Average	84	67	64	80	75	18

For the first two years the seed, properly stored, does not lose in germination per cent and the germination in the nursery equals the greenhouse. The reduced germination due to age is first shown to be three years and the nursery values fall off more than the greenhouse. Variations from year to year are negligible.

TABLE 5.—*Yellow Pine—Effect of Age on Seed*

Southern California Seed

Age	C. T.	G., 120 days	N., 120 days	G. / C. T.	N. / C. T.	No.
New	68.5	62	64	90	93	1
1 year	84	15	11	..	..	2
2 years	82	54	38	65	46	2
3 years	78	54	43	69	55	3
4 years	79	43	39	55	49	4
Average	81	46	39	57	48	13

I have next tabulated a series of tests on seed of yellow pine 4 and 5 years old, which was retested in 1916-17. The individual tests are parallel, so as to show the remarkably consistent values given. Judging from these figures, all of which are for northern California seed, yellow pine retains its vitality for five years.

TABLE 6.—*Tests on Seed of Yellow Pine 4 and 5 Years Old*

Lot	Collected	Test, 1912–1913 (per cent)	Test, 1916 (per cent)
35	1911	1912, 59	67
43	1911	1912, 59	60
101	1912	1913, 83.5	76
103	1912	1913, 64.5	72.5
106	1912	1913, 80	75.5
107	1912	1913, 73	75.5
108	1912	1913, 73.5	74
122	1912	1913, 80	78.5

Incense cedar, as may be seen in the following table, behaves in an entirely different manner. Starting with a germination of but 40 per cent of cutting test, this falls to 33 per cent when one year old and 11 per cent when two years old, with practically no germination when three years old. Certainly seed of this species should be collected fresh every year.

TABLE 7.—*Incense Cedar—Effect of Age on Seed*

Age	C. T.	G.	N.	G. / C. T.	N. / C. T.	G. / N.	No.
New	67	27	28	40	41	104	28
1 year	65	23	20	35	30	84	20
2 years	67	9	4	16	7	47	7
3 years	No germination.						
4 years	No germination.						

NUMBER OF SEED PER POUND

With the prospective elimination of seed testing in this district, it is important to have average figures for the various species. These are given below.

Table 8.—*Number of Seed per Pound*

Northern California Seed

Species	Average No. seed per pound	Max. No.	Min. No.	No. tests
Yellow pine	10,000	13,300	6,900	19
Jeffrey pine	4,040	5,400	3,650	12
Sugar pine	2,170	3,200	1,640	38
Douglas fir	....	....	....	..
White fir	16,230	25,000	12,000	..
Red fir	6,550	11,000	4,100	17
Incense cedar	15,500	29,000	6,400	55
Bigtree	80,000	100,000	62,000	16

Table 9.—*Number of Seed per Pound*

Southern California Seed

Species	Average No. seed per pound	Max. No.	Min. No.	No. tests
Yellow pine	9,750	12,360	5,100	13
Jeffrey pine	4,000	4,670	3,180	23
Sugar pine	2,200	2,360	1,900	4
Douglas fir	....	....	....	..
White fir	None			.
Red fir	None			
Incense cedar	Only a few tests.			

RELATION OF CUTTING, GREENHOUSE AND NURSERY TESTS

The work so far done shows that for some species the cutting test gives an excellent index of the germinating power of the seed, while for others it is nearly worthless. It is important to establish relationships between cutting test and germination, so that untested seed can be sown intelligently. The following tables summarize the data for the various species; individual tests are not listed:

Table 10.—*Western Yellow Pine—Results of Four Years' Tests*

Northern California Seed (Sierra National Forest North)

	Seed per lb.	C. T. (*per ct.*)	G., 120 days (*per ct.*)	N., 120 days (*per ct.*)	G./C. T. (*per ct.*)	N./C. T. (*per ct.*)	No.
Average	10,100	84	67	64	80	75	19
Maximum	13,300	94	83	78	102	101	1
Minimum	6,900	74	58	50	65	65	1

The maximum and minimum are for the individual tests showing the highest and lowest values.

The relations between germination in the greenhouse and the (Feather River) nursery to cutting-test values are remarkably consistent for all lots and for all years. The first-year greenhouse tests averaged but 75 per cent of cutting test, no doubt because they ran only 100 days. The corresponding nursery tests exceeded the greenhouse tests slightly and were 76 per cent of cutting test or just normal.

Similar figures for southern seed are shown in the next table.

TABLE 11.—*Western Yellow Pine—Results of Four Years' Test*

Southern California Seed

	Seed per lb.	C. T. (*per ct.*)	G., 120 days (*per ct.*)	N., 120 days (*per ct.*)	G./C. T. (*per ct.*)	N./C. T. (*per ct.*)	No.
Average	9,750	81	46	39	57	48	13
Maximum	12,360	90	80	80	89	100	..
Minimum	5,012	71	15	16	21	23	..

Results vary more from lot to lot and from year to year than with northern seed, and it seems clear that this class cannot be used in the northern nurseries with as much confidence as the others.

TABLE 12.—*Jeffrey Pine*

Northern California Seed

	Seed per lb.	C. T. (*p. ct.*)	G., 120 days (*p. ct.*)	N., 120 days (*p. ct.*)	G./C. T. (*p. ct.*)	N./C. T. (*p. ct.*)	N./G. (*p. ct.*)	No.
Average	4,040	79	66	62	83	78	94	12
Maximum	5,400	94	82	80	87	85	97	1
Minimum	3,650	63	45	45	71	71	100	1

The relationships are very consistent from year to year and from lot to lot. Values are nearly identical with those already derived for yellow pine.

TABLE 13.—*Jeffrey Pine*

Southern California Seed

	Seed per lb.	C. T. (*p. ct.*)	G. (*p. ct.*)	N. (*p. ct.*)	G./C. T. (*p. ct.*)	N./C. T. (*p. ct.*)	N./G. (*p. ct.*)	No.
Average	4,000	76	-50	-50	67	65	98	23
Maximum	4,670	93	80	..	96	..	..	1
Minimum	3,180	62	25	..	40	..	..	1

There is a wider range of variation than for northern seed, and, other considerations aside, the use of southern seed is undesirable because of its inconsistent behavior.

SUGAR PINE

After tabulating the results of three years' tests on over 30 lots of seed, it was evident that no positive deductions were possible. There is no consistency in results from year to year, from lot to lot, between greenhouse and nursery or between germination and cutting test. The only value of the work done is to show that results of a test on an individual lot of seed, which because of slow germination are not available till after the seed is needed, are worthless except as a very general indication of quality.

No tables are presented, since they would have no practical value.

INCENSE CEDAR

The behavior of this species is extremely variable, and general averages must be used cautiously because of the wide difference between parallel tests of the same lot of seed. For example, in 1916 three tests of the same lot gave 12 per cent, 15.5 per cent, and 23.5 per cent final germination respectively, two tests of another lot gave 3 per cent and 11 per cent, and others showed just as wide a range of inconsistency.

New seed, with equal greenhouse and nursery germination, averaging 40 per cent of cutting-test values, is the most reliable, and this figure may be accepted.

RAPIDITY OF GERMINATION

This is best expressed as a percentage figure derived thus:

$$\frac{\text{Total germ., 120 days.}}{\text{Germ. at 10, 20, 30, etc., days.}}$$

It is found that average figures for different years vary tremendously, undoubtedly because of the varying temperatures. In general, a cold, late spring delays nursery germination just as cloudy weather with low temperature does on the greenhouse tests. The specific effect of different temperatures on rapidity is, however, unknown. We can fairly average all years to secure the difference in rapidity between northern and southern seed and between old and new seed, with the clear understanding that the average values do not necessarily apply to a specific year.

Without knowing the effect of different temperatures, it is impossible to compare one year with another, so that at best the values obtained simply indicate comparative, not absolute, rapidity.

It is important to know the average rapidity of germination, since seed which germinate after about July 1 (or 80 to 90 days after sowing) produce small, weak plants unsuitable for transplanting. If, for instance, only 80 per cent of the total germination can be expected in 80 days, allowance must be made for this.

TABLE 14.—*Yellow Pine—Comparative Rapidity of Germination*

GREENHOUSE TESTS, 1913-1916

Northern California Seed

	20 days	40 days	60 days	80 days	100 days	120 days	Rap. F.	No.
Average	3	22	48	84	97	100	61	19
Maximum	11	49	77	96	100	100	40	..
Minimum	0	5	32	74	93	100	70	..

Southern California Seed

	20 days	40 days	60 days	80 days	100 days	120 days	Rap. F.	No.
Average	6	22	45	76	96	100	62	13
Maximum	20	40	69	93	100	100	50	..
Minimum	0	3	12	51	85	100	79	..

It will be noted that average values are equal up to the fortieth day, after which the northern seed gradually pulls ahead. Maximum and minimum values also indicate greater average rapidity for northern seed.

NURSERY TESTS, 1913-1916

Northern California Seed

	20 days	40 days	60 days	80 days	100 days	120 days	Rap. F.	No.
Average	1	14	53	84	97	100	59	19
Maximum	4	31	76	93	100	100	44	..
Minimum	0	2	37	66	94	100	71	..

Southern California Seed

	20 days	40 days	60 days	80 days	100 days	120 days	Rap. F.	No.
Average	8	18	42	75	95	100	62	13
Maximum	26	52	79	96	100	100	39	..
Minimum	0	0	17	44	89	100	81	..

Here, also, northern seed is more rapid and shows less variation. In comparing greenhouse and nursery variation for northern seed, it is found that the rapidity is very nearly the same at the different periods, especially from 80 days on. It may fairly be said for yellow pine that the tables are reasonably reliable. A warm spring will result in germination somewhat more rapid than the average figures and approaching the maximum, while a cold spring will have the opposite effect.

TABLE 15.—*Jeffrey Pine—Comparative Rapidity of Germination*

GREENHOUSE TESTS, 1913-1916

Northern California Seed

	20 days	40 days	60 days	80 days	100 days	120 days	Rap. F.	No.
Average	2	23	46	83	97	100	61	16
Maximum	..	69	80	99	100	100	32	..
Minimum	..	1	12	58	98	100	70	..

Southern California Seed

	20 days	40 days	60 days	80 days	100 days	120 days	Rap. F.	No.
Average	10	34	62	92	98	100	52	19
Maximum	17	56	79	94	99	100	37	..
Minimum	..	1	29	86	99	100	68	..

NURSERY TESTS, 1913-1916

Northern California Seed

	20 days	40 days	60 days	80 days	100 days	120 days	Rap. F.	No.
Average	..	10	46	79	97	100	61	16
Maximum	..	42	68	86	98	100	50	..
Minimum	..	4	43	75	97	100	68	..

Southern California Seed

	20 days	40 days	60 days	80 days	100 days	120 days	Rap. F.	No.
Average	..	22	65	90	98	100	..	19

SUMMARY

Yellow and Jeffrey pines display reasonably consistent average values for number of seed per pound, relation of germination to cutting test, and rapidity of germination. Thus we might figure as follows for a lot of yellow pine having a cutting test of 80 per cent:

Number per pound..................................	10,000
Value by cutting test..............................	8,000
Probable total germination (80 per cent cutting test)..	6,400
Effective germination (80 per cent total)...........	5,120

In other words, about 50 per cent of the total number of seed may on the average be counted on to produce seedlings suitable for transplanting.

It is hardly necessary to point out that average figures may not apply in each individual case, but the chances are at least three out of four that the variation will not exceed 10 per cent either way from the indicated values.

The other species—sugar pine, incense cedar, and the firs—show such great variability that average figures probably would apply only about half the time, with a variation of 20 per cent either way.

For such species the average number of seed per pound and cutting-test values may be used in lieu of anything better, but a wide departure from indicated values is to be expected in at least half the cases.

In collecting seed, it is safe to figure on the following basis:

$$P = Pr : \frac{N}{K}$$

Pr = total production of seedlings, expressed as M.

P = number of pounds of seed.

N = average number of M seed per pound.

K = constant; 2 for yellow and Jeffrey pines; 4 for sugar pine; 5 for incense cedar.

THE RÔLE OF ARTIFICIAL REGENERATION IN THE RE-ENFORCEMENT OF HARDWOOD WOODLOTS

By Edmund Secrest

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Woodlot practice will become a reality in agricultural communities when the farmer eventually applies efficiency methods to his business and when economic conditions make silvicultural operations financially possible. Neither stage has been reached in Ohio, but if present indications are of evidential value the time is not far off. It will mean the reduction of woodland area within the State, but this will only stimulate agricultural production and will be welcomed in the great plan of economy. Ohio is essentially an agricultural State and one of relatively small farms. The status of a considerable portion of the 3,500,000 acres of woodland stands in unique relation to that of most other States. This area has a high ratio to land values, and the natural tendency respecting it has been one of most intensive exploitation, of which grazing has been the chief contribution. The grazing practice, in the estimate of the owner, has been his chief revenue. In conformity with the condition of many of these tracts, his conclusions are correctly deduced, which, however, in no way excuses this practice. The owner would save the mature trees and destroy the reproduction. His interest in the forest is the material ready for conversion, which should supply the needs of the farm plant. His habits of thought and practices inadvertently are inimical to his best interests. Determining the status of a woodlot is foreign to his conception.

The grazed woodland constitutes 80 per cent of the total for the agricultural sections, the latter being approximately 75 per cent of the land area of the State. Greater or less injury has occurred in consequence and the resultant loss to these communities and the State at large has been significant. Unlike the fire menace, this practice cannot be controlled by legislation and its very insidiousness makes it difficult to combat. It is at best possible to control only through education. The testimony of land-owners is to the effect that the annual value of the average woodland pasture does not exceed 50 cents per acre, and that derived mostly from browsing.

Although the basis of operations, mere protection alone will not accomplish profitable reconstruction. Individually every woodlot must be considered a type in itself. The conditions superinduced have in effect so altered the character of the original stand that detailed plans of procedure for the specific natural types are apt to confuse the average land-owner or they may fall short of his needs. In addition the economic situation has not been encouraging. Fifty years ago cordwood was worth more in most sections of the State than it was prior to the outbreak of the European war. Coal and gas had practically driven it out of the market. Mine timbers barely paid for cutting and delivery. Charcoal offered such a limited market that its manufacture was rarely profitable. There was consequently little opportunity for the disposal of inferior timber. The outlook was not encouraging for intensive operations on land of questional woodlot value. Notwithstanding these conditions, the farmer has maintained a passive interest in the woodlot. Sentiment admittedly was a factor of consequence, but sentiment is crystallizing into a conviction that keener competition in farming cannot tolerate the present type of woodland. The woodland pasture will go; whether a regenerated forest will result or it will be removed entirely will depend on the owner and his advisers. Certainly the woodland area in the agricultural regions will be reduced.

No one questions the potentialities of the hardwood woodlot. The great majority of those grazed can be profitably rejuvenated by natural seeding under proper methods. It is obvious, however, that under some conditions artificial re-enforcement must be employed. The nature of the growth, the local demands, and those of the farmer himself will often warrant introductions to meet these needs. The owner's interest lies chiefly in the material he can grow for his own use. Fence-post consumption exceeds that of all other farm timbers. Durable native woods are largely exhausted. Wood preservation, despite unlimited raw material and practical demonstration, has not come into favor. The condition of the average woodlot was such that artificial re-enforcement could be employed to provide those needs. Existent open spaces kept clear by heavy grazing and those made by the removal of cull or mature material afford opportunities for interplanting. Experiments in these operations have met with varying success. Yellow locust, osage orange, European larch, and catalpa were used at the outset because of their post value. From a biological aspect, the use of locust in pure plantation is no longer advisable on account of the infestation by the borer (*Cyllene robinæ*). Material reduction in infestation has been noted in several cases where the species was introduced into woods among associates of the native growth. Pure plantations of locust established on the Oberlin Municipal Forest in 1904 have been entirely destroyed. On this forest is a native woodland severely grazed prior to 1902. Six years after the live stock was excluded a seeding of ironwood, blue beech, and sugar maple became established on a portion of the tract. One-year seedlings of locust (18 to 24 inches) were introduced into this seedling at the rate of 1,200 per acre. Seventy-five per cent survived rather unfavorable soil conditions at the time of planting. The natural seeding ranged from 1 to 2 feet in height. The locust developed satisfactorily and succeeded in maintaining crown freedom. No liberation was necessary, although competition with the associate growth was keen. The borer infestations were practically nil. A locust planting under similar conditions was made in an oak woodlot in southwestern Ohio, but on better-drained soil than that at Oberlin. At approximately 25 years the trees have attained a diameter of 8 inches and a height of 45 feet and are of excellent form. There was no evidence of borer infestation. Neighboring plantations were severely injured or destroyed. Other plantings under similar conditions may be cited as evidential value to support the claim that the species may be successfully handled in mixture where it will fail in pure plantation, providing, of course, there is no interference from the overwood crowns. The character of the tree appeals to the farmer; and its general use under favorable conditions seems advisable if, as there is reason to believe, borer infestations can be minimized.

The osage orange, owing to its tolerant character, would seem more adaptable for interplanting than the locust. The species is difficult to establish under sod conditions and it does not tolerate a wide range of soils. Its undesirable form in pure plantation, however, can be materially improved when intermixed with associates of natural seeding. Introduction should succeed the reservation from live stock within one or two seasons in order to prevent undue competition.

Re-enforcement with catalpa has on the whole not been satisfactory to date. Introductions in open woodlots on warm limestone soils in south Ohio have been successful. The species has two characteristics which tend to minimize its usefulness for this purpose. It is extremely intolerant and it recovers slowly from the effects of transplanting in sod. It is prone to be outgrown on heavy mineral clays and deficient sandy soils by the natural seeding. Since heavy sods are characteristic of many open woodlots, the species must be introduced soon after grazing ceases. In this event it may become established soon enough to outstrip its competitors. At the Oberlin Forest one-year seedlings, 18 to 24 inches, were interplanted in a natural seeding of ironwood and sugar maple 6 to 12 inches high. The sod cover had not yet been destroyed. After a period of 10 years the catalpa have been overtopped by the native growth. A liberation might save them, but the lack of adaptation to soils would hardly warrant this procedure. The species rarely fails to survive transplanting, even under most adverse conditions. It will persist, and cases have been known where the height growth has only been 1 to 2 feet in 10 years. In northeastern Ohio a heavily grazed woodlot was re-enforced with one-year catalpa seedlings two years following the removal of stock. The site was an eastern exposure of fertile, well-drained sandy loam. The open area, approximately one-third acre, contained a natural seeding of ironwood, sugar maple, black gum, and a few scattered tulip poplar from 2 to 8 inches high. Light conditions were favorable for the catalpa. In the 11-year period the species has held its own with the poplar and will probably reach maturity. The average annual height growth the first three years was 2 feet.

The European larch may be regarded as a species of value in open woods among natural seeding of inferior quality. Its adaptation to soil range is not as restricted as that of the osage orange and catalpa and its form and rate of growth are much superior. It can be easily handled in hardwood mixtures, particularly that of ironwood, blue beech, sourwood, gum, etc. The easily distinguished character of the tree is of considerable advantage in facilitating liberation cuttings in dense growth.

The Russian mulberry (*Morus alba*) may be left out of consideration entirely as a factor in wood production, although it may occasionally be employed as a windbreak on southerly and westerly exposures of open wind-swept woodlots. Its wood is extremely durable, but the tree rarely produces merchantable material.

Ohio forests are characterized by two typical areas—the beech-maple type, with associates of tulip poplar, white ash, linden, ironwood, black gum, and red oak. Following severe grazing, this type rejuvenates rapidly and satisfactorily if properly managed. Even though neglected, the superior commercial species, such as white ash, tulip poplar, and linden, become dominant trees in the stand, providing they are not suppressed by an overwood. This type perpetuates itself more satisfactorily than any of the hardwood region and its character changes less from generation to generation. As a subsequence, artificial regeneration may be little needed to retard degeneration. The oak type, composed of the various species of oak, with associates of chestnut, black gum, ironwood, sourwood, the several species of hickories, may, on the other hand, be changed radically in character through heavy grazing from one generation to the next. This change is often one of degeneration. The preponderance of such species as ironwood (*Ostrya virginiana*), blue beech (*Carpinus caroliniana*), black gum (*Nyssa sylvatica*), in reproduction and second growth in many woodlots of the oak type, is a disturbing factor, since it means the establishment of a permanent type. The tolerance of these species, once they are established, will exclude the seedlings of the oaks, hickories, and other intolerant associates of the original oak type. A case in point is a 14-acre oak woodlot in central Ohio. White oak originally preponderated, with associates of black, red, and scarlet oaks. The removal of the white oak 60 years ago was followed by a reproduction of the red-oak group, which now forms the overwood. Live stock had been excluded 10 years prior to observation, at which time a dense reproduction of ironwood had become established. Oak did not compose 1 per cent of this stand. The seeding was made by six mature ironwoods. The future status of this wood and many other like it is not one of promise in a highly specialized agricultural community. It demonstrates the vigilance required in operations following the removal of live stock. It has been observed, however, that the removal of seed trees of these species at time of reservation from grazing does not always accomplish the desired result. Seedlings may persist for years during the period of grazing, only to spring up with vigor under protection. Skillful manipulation at the critical period may often produce satisfactory results, but the difficulty lies in handling such areas at the proper time. Experience has demonstrated that it may not be as difficult to outline a workable method of procedure as it is to get the plan carried out by the owner, especially if any skill or particular knowledge may be required on his part. This fact is frequently a discouraging feature in developing the maximum possibilities of natural seeding. The layman's conception of forestry is tree planting, and it is going to take considerable schooling to educate him to some of the intricacies of intensive woodlot practice. Unquestionably, artificial re-enforcement must play an important rôle in bringing woodlots of the oak type to a satisfactory state of production, and undoubtedly the present generation must bear a burden of expense to accomplish this end. In the process many of the woodlots must be clear cut, entirely restocked, or transferred to other sites. The native species—tulip poplar, white ash, red oak, linden, and others—are well adapted for re-enforcement, and especially among the ever-present and tolerant weed growth.

Conifers also will be used in converting oak stands on sites of low quality. This is obvious from results with white, red, and shortleaf pines. Eventually a considerable per cent of the oak sites in the unglaciated section of southeast Ohio will be replaced with pine. This is particularly applicable to the areas in which the growth has been removed three and four times for charcoal during the days of the charcoal furnaces. The character of the present rotation has so degenerated that it is virtually one of no merchantable value, actual or potential, excepting for charcoal. Proximity to the great coal fields precludes utilization for cordwood. When economic conditions favor the cutting of these tracts, pine planting will follow. Enough of this work has been done to indicate the adaptation of conifers.

The outlook for intensive woodlot practice is constantly improving. The economic demands of the war, especially with respect to cordwood, will give a tremendous stimulus to the movement. It will provide a market for the wood waste, the lack of which has heretofore been a most deterrent factor in promoting intensive operations. Even though the stimulus is temporary, it will fix habits of thought and action which in itself will be a helpful element in determining the future status of the farm woodlot.

A PRACTICAL REFORESTATION POLICY

By George A. Retan

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Recently there have appeared tentative plans forecasting the extent and expense of the reforestation work to be done in Pennsylvania. It has been assumed that 75 per cent of the State-owned land must be reforested artificially, the whole operation to be completed within one rotation. It has been estimated that the total expense of this plan, allowing compound interest, will amount to nearly four hundred million dollars by the end of the 75-year rotation, and will be refunded by 15 years after final cutting begins.[1] It has been claimed by several writers[2] that the State ought to own six million rather than one million acres. At the given rate the reforestation of this area would require an expenditure of over two and one-half billion dollars. Before accepting such a plan, it may be worth while to examine the silvical and economic status of the area in question, to ascertain what meliorating factors may be present, and to suggest a practical policy for the work.

Such an examination will show that the State ought to own a much larger area than it does; that immediate reforestation is unnecessary, owing to the good silvical condition of the State forests; and that planting ought to proceed according to the economic development and growth conditions by methods proved applicable.

There are about fourteen million acres of land in Pennsylvania that may be classified as woodland[3] or absolute forest land. Of this, approximately nine million acres are not included in farm woodlots. This area is in comparatively large blocks of contiguous forest and should be secured by some owner, whether State or corporate, who is willing to protect and improve it.

At present the State owns one-ninth of this area, more or less concentrated in the central counties. Three or four million acres, lying at the headwaters of the Susquehanna and Ohio rivers, is, as yet, largely

[1] Fernow, B. E.: "State Forestry." Forest Leaves, August, 1917.

[2] *Ibid.*, p. 55.

Ziegler, E. A.: "The Immediate Need of Extending State Forests." Forest Leaves, August, 1915, p. 62. "Pennsylvania's Potential Forest Area and Land Policy." Forest Leaves, June, 1917, p. 34.

[3] *Ibid.*, June, 1917.

held by corporations for its mineral possibilities, with its surface neglected. The people of western Pennsylvania claim that this land ought not to be allowed to become waste. Certainly it is most important from the viewpoint of watershed protection. Surrounding the present State holdings are other large areas absolutely uncared for. Six million acres, 21 per cent of the State, is not an excessive estimate of the lands that the Forestry Department ought to control.

The million acres at present owned have cost to date about five million dollars, one-half of which was paid for the land. At the same price, and this is too low a figure, twelve and one-half million dollars must be paid for the additional five million acres. Costs of survey, examination of titles, and administration will accumulate to a total of nearly twenty million dollars by the completion of the purchase.

Even with very generous appropriations, without a bond issue there will be relatively small amounts available for reforestation for some years. The failure of the bond issue for roads is not a favorable omen for the success of one for reforestation. Experience has proved that it is easier to obtain appropriations for the purchase of land than for plantation work.

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Silvical and economic considerations point to the reasonableness of a policy directed toward purchase. The central mountainous region of the State, in which a large percentage of the State forests lies, is characterized by four main types:

(A) Yellow pine, occupying the thinnest, highest, and driest soils of the ridges; largely protection forests.

(B) Rock oak and chestnut slopes, where the soil conditions are somewhat better than the preceding, but the two often intermingling.

(C) Scrub-oak flats, the badly burned areas.

(D) Hardwood benches, characterized by the deepest soils and possessing a good stand of the central hardwood region, chestnut predominant.

In all of these types except the scrub oak the growth is good. Even where the "blight" is killing the chestnut, the stand is being replaced with a valuable seedling stand. Sample plots on the Mont Alto State Forest, where the chestnut is dying rapidly, gave the following data:

Plot I.—Upper hardwood bench, composite forest 12 to 25 years old, quality II. Overwood recently cleared away. Trees over one inch in diameter:

Rock oak, 1,848 per acre, 74 per cent; chestnut, 488 per acre, 20 per cent; black oaks, 142 per acre, 6 per cent.

Plot II.—Rock oak and chestnut slope, coppice hardwoods uneven-aged because of fires, quality III. Overwood composed of 312 trees to the acre, of which chestnut forms 77 per cent and rock oak 12 per cent. The chestnut is rapidly dying and a regeneration is present as follows:
Rock oak, 14 per cent; black oaks, 40 per cent; weeds, 46 per cent; total, 3,400 seedlings per acre.

Plot III.—(Average of several.) Lower hardwood bench. Overwood cut this summer. Composition:
Chestnut, 79 per cent; rock oak, 4 per cent; black oak, 17 per cent.
The reproduction consisted of over 2,000 seedlings and sprouts. Composition:
Rock oak, 30 to 40 per cent; black oak, 20 per cent; white pine, 5 per cent; weeds, 35 to 45 per cent.

Plot IV.—Rock oak slope, quality II. Hypermature rock oak and chestnut. Average of over 40,000 rock oak seedlings from 1 to 5 years old present.

While these sample plots do not pretend to be exhaustive, they are nevertheless typical of minimum rather than maximum conditions. The whole area, except the scrub-oak flats, is at present producing a composite forest of nearly normal density, with oak forming at least 50 per cent of the stand.[4]

The northern plateau region, stretching across the northern tier of counties and extending southward along the divide between the Ohio and Susquehanna watersheds, presents a less favorable appearance. This area was the home of the original white pine and hemlock. Lumbered first for pine, then for the hemlock, and finally for the hardwoods, and then repeatedly burned, this section has seemed to require artificial reforestation on a large scale. The writer has shared this view. But the last few years have greatly changed conditions. Adequate fire protection, by giving nature a chance, has accomplished a wonderful work of restoration. The greater portion is being covered with a sprout and seedling growth varying somewhat in density and composition, but forming everywhere a valuable soil cover and a great obstacle to successful planting. Sample plots show the following conditions:

Plot I.—25,000 seedlings, almost entirely aspen, 1 to 15 feet high.
Plot II.—2,900 fire cherry and 1,600 aspen, with scattered hardwoods.[5]
Plot III.—Overwood of pitch pine with natural seed regeneration of 2,000 to 3,000 per acre.
Plot IV.—(Average of four.) Typical of largest acreage:
Oak, 720 per acre, 23 per cent; chestnut, 1,894 per acre, 62 per cent; weeds, 464 per acre, 15 per cent; pine, 4 per acre.

[4] Retan, G. A.: "Silvicultural Consideration of Forest Conditions in Pennsylvania." Forest Leaves, June, 1916.
[5] Illick, J. S.: "Forest Tree Planting Camps." JOURNAL OF FORESTRY, April, 1917.

Other areas show larger percentages of beech, birch, and maple, replacing the oak and chestnut.[6] So completely are these areas filling up that the reports of the Pennsylvania foresters are more and more optimistic as to the future of the region.[7] The least promising areas are certain upper slopes where hardwoods were not originally present.

The spread of oak and other hardwoods over this area is a most striking phenomenon and one deserving of further investigation. The virgin forest at present being lumbered on land similar to that on which the preceding plots were taken, and not far removed, contains the following species: Hemlock, 92 per cent; oak and chestnut, 5.9 per cent; beech, birch, and maple, 1.3 per cent, and pine, .8 per cent. Based on the 1917 cut to date, oak and chestnut have increased to 12 per cent.[8]

Any reforestation policy must take into consideration the present and future economic possibilities as well as silvical conditions. The economic status of the central mountainous section is by far more promising than that of the northern plateau region. Here the agricultural and industrial needs are effecting a constant improvement in market conditions. As the forests occupy parallel ridges, with intervening agricultural valleys traversed by railroads, most of them are within easy hauling distance of a railroad siding. At present the salvage of the dying chestnut obscures this development. Further, as yet, 90 per cent of the imported timber comes from the South and East and only 10 per cent from the Pacific coast. Greeley says: ". . . the handicap of high freights in reaching the American markets will tend to restrict imports of foreign timber largely to hardwoods and special products."[9] Observation in the Rhine timber markets shows that the competition is most severe in large-sized products brought in by water freight. Yellow poplar at Carlsruhe was cheaper than Black Forest fir; but hardwood firewood from the coppice forests along the river brought a very high price. There is evidence of the same tendency in this region. On the Mont Alto Forest the receipts, largely for small stuff, were $2,600 in 1917, as compared with $1,300 in 1914. Operations on the Nittany, Caledonia, and Pine Grove forests point to the same conclusion.

Conditions are very different in the northern part of the State. This section is sparsely inhabited; the population is decreasing. Railroads are being torn up instead of built. Once prosperous villages are gone or are represented only by the houses of a few hunters or farmers.

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[6] Data furnished by Foresters Harbeson and Morgan, of the Blackwells and Slate Run State Forests.

[7] Pennsylvania Forestry Report, 1912-1913, and foresters' manuscript reports.

[8] Cut of Leetonia mill for 1916 and 1917, secured by Forester Harbeson.

[9] Greeley, Wm. B.: "Some Public and Economic Aspects of the Lumber Industry," p. 52.

Here or there a coal mine or a quarry supports a local population. Vast areas of State forests are many miles from a railroad. A market for cleanings or improvement cuttings must await the future.

Yet this is a section of great industrial promise. It abounds in water-power that must be depended upon to replace our vanishing coal and oil. Impounding sites are easily located and will demand no land now used for other purposes. When the time arrives for the utilization of this power, the timber will be close at hand and greatly in demand. Thus the economic conditions point to the necessity of centering attention first on the forests of that section where the present market for small-sized material makes thinnings and improvement cuttings possible. This will accomplish two purposes: it will meet the objections of those citizens who complain that forestry calls for constant expense without return, and it will make financially possible the speedy transformation of the composite forest into a better-paying high forest with coniferous admixture.

Experimentation has proceeded sufficiently far on the State forests and in other similar regions that a reasonably accurate forecast of the success and expense of reforestation may be made. It is shown that areas which are covered with hardwood coppice of any considerable density cannot be clear cut and planted with any prospect of success unless two or three subsequent cleanings are made. Growth under such conditions in typical plantations without cleaning is:

Central mountainous region—
- White pine in five years, 12 inches, uncleared.
- Plateau region in five years, 17 inches, cleared.

Plateau region—
- White pine in five years, 11 to 14 inches.
- Norway spruce in five years, 9 to 13 inches.

Where subsequent clearings are necessary, the plantation costs are made prohibitive for the given conditions. The first cost of clearing areas for planting has been from $5 to $10 and more per acre, depending upon the density of the brush. About 900 trees are planted at a total cost of approximately $6 per acre. Where subsequent clearings are necessary, $15 per acre is a minimum total cost for all operations. Burning may eliminate the first clearing cost, but it is often inadvisable because of its influence on public sentiment. For this reason only the most barren areas are now being planted; such do not require any preliminary burning or clearing.

Richards[10] summarizes results of similar operations carried on in the

[10] Richards, E. C. M.: "Study of Reforested Chestnut Cut over Land." JOURNAL OF FORESTRY, May, 1917.

Eastern States. Troup[11] deals with similar work in France. I have seen such planting in Germany as well as considerable of that in Pennsylvania. The conclusion seems warranted that it is more advisable to allow the hardwood growth to continue to maturity before transformation takes place. It may then be undertaken by underplantnig or by natural regeneration assisted by planting. French practice, and the French excel in this line of silvicultural activity, is to allow the coppice on one of four or five periodic blocks to grow to an age of 50 to 80 years, and then transform either by natural seeding or by underplanting after thinning. Final cutting takes place only after the young growth is able to take care of itself. A vital mistake made at first by the French was to allow the coppice to become even-aged over large areas before beginning the transformation, instead of continuing for 50 to 100 years the utilization of the blocks which were not to be treated immediately. This indicates the value of developing the small-stuff market and utilizing our younger woods. Shingle and stave mills are now being used on some Pennsylvania State forests and will aid in accomplishing this purpose.

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Silvical and economic conditions, then, as well as silvicultural experience, prove that we can continue the necessary work of purchase of woodlands without the sacrifice of an adequate reforestation policy. Such a policy must meet the given conditions. It consists:

First, in the recognition of the basal fact that adequate protection will lead to the restoration of a good hardwood cover on State forests.

Secondly, the present and future poorer economic condition of the plateau section points to the lack of a necessity for an aggressive reforestation policy there. Only the most barren sites and the areas promising most economically need be planted for a considerable period. By the time the work has reached that section the development of market conditions will enable the stand then present to yield sufficient revenue to meet the cost of reforestation.

Thirdly, the central mountain section, with its better market conditions, should be utilized more closely under a coppice rotation of from 25 to 40 years. The first periodic block should be differentiated now and transformation be started. Such a transformation may be easily accomplished by natural regeneration and by underplanting of the blanks with conifers a few years before the final clearing.

Such a policy will not require an immediate investment by the State to the extent of demanding unusual measures and jeopardizing the whole work.

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[11] Troup, R. S., Assistant Inspector General of Indian Forests: "Note on Some European Silvicultural Systems." Calcutta, 1916.

DOES EASTERN WHITE PINE OCCUR ON SITES IV AND V?

By Ralph C. Hawley

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In a note entitled "More about Sites"[1] Recknagel attempts to show from data collected in the Hudson River watershed, New York State, that white pine is there found growing on sites which in Europe would be classified as IV or V. This note is intended to amplify his statement to that effect appearing in the *Proceedings of the Society of American Foresters,* Vol. XI, p. 441. Even if Recknagel's contention as to the existence of Sites IV and V in this region later proves to be well founded, yet the figures which he has presented, when rightly interpreted, disprove instead of support his statements. This may be shown as follows: In his article he lists 19 sample plots, all of which fall within qualities I-III except three plots, numbers 3, 6, and 11. These he indicates as Sub III, and to substantiate his previous statements must identify as IV. The standard for comparison he takes as Tables 3, 4, and 5, in Bulletin 13.[2] Height is taken in Bulletin 13 as the basis of separation into qualities and this is accepted by Recknagel. The same figures of age and height which he uses are taken from Tables 3 to 5, Bulletin 13, and from his plots and combined below with additional figures.

Site.	Values from Tables 3 to 5, Bulletin 13.				Relative values based on Site I values as 100.			
	35 years.		50 years.		35 years.		50 years.	
	Volume, cubic feet.	Height, feet.	Volume, cubic feet.	Height, feet.	Volume, cubic feet.	Height, feet.	Volume, cubic feet.	Height, feet.
I	5,200	53	8,800	74.5	100	100	100	100
II	4,180	44.5	7,000	64.0	80	84	80	86
III	3,100	36.0	5,200	54.0	60	68	59	72
IV	....	27.5*a*	....	43.0*a*	...	52*b*	...	58*b*
Sub. III.....	....	....	2,356	40.0	Recknagel's Plot 3			
Sub. III.....	....	....	3,424	48.5*c*	Recknagel's Plot 6			
Sub. III.....	2,840	33.5	....	....	Recknagel's Plot 11			

a Derived by use of the relative values and not given in Bulletin 13.
b Not derived directly with aid of a Site IV height, because none exists, but secured by a proportional reduction of the relative values of Sites I to III.
c Age, 49 years.

[1] Journal of Forestry, Vol. XV, pp. 929-930.
[2] "White Pine under Forest Management." Bulletin 13, U. S. Dept. of Agri.

In order to classify Recknagel's plots accurately, heights at 35 and 50 years for Site IV were secured by the method indicated in footnotes *a* and *b*. It is now possible to judge the position of these plots. Plot 3, 50 years old, corresponds closer to the height for Site III than for Site IV. Plot 6, 49 years old, is midway between the 50-year heights for Site III and for Site IV. Adding the mean annual growth of 1 foot for one year brings the plot nearest to Site III. Plot 11 is only slightly below the Site III height for 35 years and far above the Site IV value.

Furthermore, Recknagel's three plots are from 26 to 55 per cent below the normal stocking in number of trees for Site III, and hence the heights may be expected to fall slightly below those in the yield table. It is granted that the height growth is largely independent of density of stocking, but what small differences in height growth may exist as between normally stocked and understocked stands of ages 35 to 50 years tend to be in favor of the former.

Table to Compare Density of Stocking

Years.	Number of trees per acre.			Basal area.		Average diameter.	
	Bull. 13, Site III.	Recknagel plots.		Bull. 13, Site III.	Recknagel plots.	Bull. 13, Site III.	Recknagel plots.
		No.		*Sq. feet*	*Sq. feet*	*Inches*	*Inches*
35.......	1,400	11	660	167	157	4.7	6.6
50.......	....	3	344	...	106	..	7.5
50.......	764	6	565	204	134	7.0	6.6

Since the values in a yield table represent the averages for each site, Recknagel's plots would, under our practice, be considered as poor examples of Site III as made in Bulletin 13. If European

Site.	Scotch pine, Schwappach (1908).		White pine, Bulletin 13	
	Height, feet.	Relative value based on Site I values as 100.	Height, feet.	Relative value based on Site I values as 100.
	35 years			
I	45.6	100	53	100
II	38.7	85	44.5	84
III	30.8	67.5	36.0	68
IV	23.0	50.5	27.5*a*	52
	50 years			
I	62.0	100	74.5	100
II	51.8	84	64.0	86
III	42.6	69	54.0	72
IV	32.8	53	43.0*a*	58

a Not taken from Bulletin 13.

standards of yield-table construction are followed, the plots would even more definitely fall under Site III, since the intervals between heights of stands of different sites for the same age averages slightly larger than that used in Bulletin 13. This is illustrated by comparing Schwappach's Scotch pine heights with white pine heights in Bulletin 13.

It is the opinion of the writer, based, however, principally on observation, general knowledge of the region, and the absence of contradictory data, that white pine in naturally reproduced stands does not occur in the Northeastern States on sand plains sufficiently poor fall decidedly below Site III and make necessary a Site IV or V.

Possibly certain areas of very poor sterile sand may be found not originally covered with white pine and on which the tree does not *reproduce naturally*. Stands *artificially* established on such soils might fall decidedly below Site III, and make necessary a Site IV or V.

The occurrence of white pine as a type in the Northeast is principally below 1,500 feet, hence the poor sites of the upper slopes and mountain tops are avoided. Throughout southern and central New England pine has been planted over a wide range of soils; in some cases on very fertile soils originally occupied by hardwoods.

On these best soils possibly growth averaging much better than present Site I may be secured. If so, this would tend to raise the values for Site I in the new yield tables needed for planted and managed stands, and, thus broadening the total range of values, might make necessary a Site IV.

For the Lake States, Zon[3] and Recknagel[3] have suggested the existence of Sites IV and V for white pine. A yield table for Norway pine in the Lake States[4] shows a sufficiently wide range of volumes (board feet, however) to justify four site classes.[5] Will this hold true for white pine? Unquestionably there is more basis for expecting to find Sites IV and V for white pine in the Lake States than in the Northeast. In the former region white pine is near the western limit of its range and is growing under more adverse climatic conditions, which must be reflected in the yield and development of the stand. Precipitation, for example, is appreciably less than farther east.

Until a series of plots is taken covering Lake States conditions, the facts must remain undetermined. A most interesting field for investigation is offered.

[3] *Proceedings of Society of American Foresters*, Vol. XI, p. 441.
[4] "Norway Pine in the Lake States." Bulletin 139, U. S. Dept. of Agri.
[5] See page 8 of article by Roth, *Forestry Quarterly*, Vol. XIV.

REVIEWS

Working Plan for Forest Lands of Peninsula State Park, Door County, Wisconsin. Bulletin 3, Conservation Commission. Madison, Wis. 1917. Pp. 43.

We welcome this effort of subjecting a State forest property to a detailed examination and the formulation of a working plan as an educational method of making the public understand what forestry involves, for to make such an elaborate working plan for a cut-over tract of less than 3,700 acres, averaging 80 trees over 6 inches, with hardly 1,500 feet to the acre, and furnishing annually a cut of 100,000 feet, can be justified only for its educational value; for practical administration, something simpler would have sufficed. It would have been wise in formulating the report to keep this educational function more prominently in mind by giving here and there explanations which, to be sure, the technical man does not need. Especially in the calculation of the "allowed annual cut"—the felling budget—the layman will be puzzled as to how this wisdom has been derived, especially since by one method 77,000, by another method 147,000, feet are allowed.

The fact in itself that the park is primarily to serve as a place for recreation makes all the interesting increment data unnecessary and the felling budgets independent of calculations; silvicultural considerations only need to be kept in view. To be sure, the commission proposes to change the policy of the park idea and combine with it a management for wood supplies. Even with this idea in view, a simple, common-sense plan would have sufficed.

There is no harm done, however, by going into the details and formulating a regulation plan as for a proposition which could be organized for sustained-yield management.

The common-sense silvicultural felling plan is clearly expressed on page 19: "The aim in cutting will be to secure a continuous improvement in the value of the woods. A stand of the most desirable trees is to be worked for. To this end the following rules are set forth: Cut no ash unless defective or dying. Cut no more white pine or red pine than is absolutely necessary to remove defective and dying individuals. Confine the cutting to hemlock, beech, maple, basswood, and oak, always keeping in mind the diameter limits. Poplar and birch can be cut at any time if a market for them is secured."

The rotation *age* (an unnecessary addition!) is based on diameter, for most species 14 inches. We object professionally to this misuse of "rotation" in tables 5 and 6. Rotation is a term applicable only to a whole working group or forest as a whole, the time within which the whole forest will be cut over, while here merely the time required by trees of different species to attain a certain diameter is intended, which is better called "felling age." This felling age varies in the same stand from 55 to 180 years.

Planting plans for the open agricultural ground are made, averaging 80 acres per year, with a uniform spacing of 6 by 6 feet for all sites and all species—white, red, and Scotch pine; Norway and Douglas spruce—which for park purposes may be good enough, but for silvicultural purposes is at least a doubtful proceeding.

To the professional reader the collection of growth tables, derived from various sources, will be welcome.

The collecting of data and the forest survey was done by C. H. Guise, of Cornell University, under the direction of Commissioner Moody.

Proof-reading in the botanical list of plants is carelessly done.

B. E. F.

Plant Materials of Decorative Gardening: The Woody Plants. By William Trelease, Urbana, Illinois. Published by the author.

A number of books and pamphlets of handy size for field use have appeared in recent years descriptive of our indigenous trees and shrubs of particular regions. These publications have been highly useful to the forester in enabling him to identify the woody species that naturally occur in the regions covered by them. There have been few similar publications useful to the forester in identifying the numerous trees and shrubs used in landscape architecture and in street planting. Almost every forester is called upon at times to identify trees and shrubs used for decorative purposes. The small, handy volume of pocket size recently published by Dr. Trelease should be available for every forester practicing his profession in eastern United States. The purpose of the book is to make it possible for any careful observer to learn the generic and usually the specific name of any hardy tree, shrub, or woody climber that he is likely to find cultivated in eastern United States, apart from the extreme south. There are enumerated and classified 247 genera and 782 species, with some 375 minor forms, or over 1,150 distinct kinds. In order to keep the book compact and of size to fit the pocket, identifications are provided for in keys. The brevity of the descriptions is both an advantage and a disadvantage. As Dr. Trelease says: "The keys should lead to reasonably certain conclusions, but no key in itself is to be regarded as final and determinations should be checked by reference to Bailey's Cyclopedia of Horticulture and other standard works."

The book is altogether the most concise treatment for purposes of identification of practically all the cultivated woody plants in eastern United States that has yet appeared.

J. W. T.

RECENT PUBLICATIONS

West Coast Lumberman, XXXIII, November 1, 1917—
Food Consumed in Logging Camps. Pp. 23.
Costs of Production in Sawmills and Logging Operations. Pp. 26–27.

Bureau of Industrial Research, University of Washington—
The Effect of Creosoted Wood Stave Pipe on Water for Domestic and Irrigation Uses. Bulletin No. 1. Pp. 1–14.

West Coast Lumberman, XXXIII, December 1, 1917—
Preservative Treatment of Wooden Ships. Pp. 24–25.

West Coast Lumberman, XXXIII, December 15, 1917—
Methods Used in Riving Airplane Spruce. Pp. 22–23.
Complete Description of the Davis Ocean-going Log Raft. Pp. 28–29.

West Coast Lumbermen's Association, Comparative Fire Resistance of Roofing Materials—
Report on Tests Made at the University of Washington. Pp. 1–16.

The Mountaineer, X, 1917—
How to Know Trees. By H. A. Winkenwerder. Pp. 51–54.

Phytopathology, VII, June, 1917—
Synthetic Culture Media for Wood-destroying Fungi. Pp. 214–220.

Schweizerische Zeitschrift für Forstwesen, 1917—
Die wirtschaftliche Zerlegung einer Betriebsklasse in Abteilungen. By H. Burger. Pp. 302–309.
A detailed account of the history and principles of forest districting.

Revue des Eaux et Forets, LV—
Les Forets du Gouvernement d'Irkoutsk. Pp. 326–331.
Notes sur les forets de l'Algerie (reviewed). Pp. 337–345.

Pulp and Paper Magazine of Canada, XVI—
Taxation of Timberlands. Pp. 67.

Engineering and Contracting, XLIX, February 6, 1918—
The Cost of Planting Boulevard Trees. H. R. Ferriss. Pp. 148.

Journal of the Association of Official Agricultural Chemists, III, May 15, 1917—

Lime Requirements of Some Acid Soils. Pp. 139–140.

Determination of the Lime Requirements of Soils by the Use of Calcium Carbonate. Pp. 141–144.

Determination of Phosphorus in Soils. Pp. 149–150.

The Chemical Engineer, XXVI, November, 1917—

Vegetable Dyes in the Philippines. Pp. 21.

Railway Maintenance Engineer, XIV, January, 1918—

The Identification of Timber. Arthur Koehler. Pp. 4–7.

Southern California Magazine, I, January, 1918—

The Torrey Pines of San Diego. Pp. 1–2.

Bungalow Magazine, VII, February, 1918—

Destruction and Preservation of Wood. H. V. Walsh. Pp. 42-45.

This article is a splendid example of misinformation on this topic, evidently written by a person with no experience in this field.

Botanical Gazette, LXV, January, 1918—

Independent Evolution of Vessels in Gnetales and Angiosperms. Pp. 83–90.

Kieth's Magazine, February, 1918—

The Use and Abuse of Wood. Pp. 124–125.

PERIODICAL LITERATURE

SILVICULTURE, PROTECTION, AND EXTENSION

Natural Reproduction Following Fire

The JOURNAL OF FORESTRY, Vol. XV, No. 8 (December, 1917), contains a review of researches by J. V. Hofman on reproduction of conifers following fire in the Pacific Northwest. The present reviewer feels that further comment on this subject is essential with reference to one or two points. The chief impression of Hofman's work gained by the reviewer as a result of some ten years of experience and observation in the Puget Sound region is that he has given far too little emphasis to cones left on trees after fire as a source of seed.

The facts are that the overwhelming proportion of serious fires in the West Cascade region occur from July 20 to September 10. Very few indeed of these fires are crown fires. Only one crown-fire area of large extent has come under personal observation of the writer in the northern portion of the western Cascades. When fires occur in seed years before the cones open (cones do not open in western Washington till near or after the end of the fire season), the result must be that large amounts of seed escape the fire and drop later on ground well prepared for reception of the seed and fairly well rid of rodents. Since Willis shows in the same number of the JOURNAL cited above (p. 992) that seed collected August 3 from green Douglas-fir cones has a germination as high as 16 per cent, it is obvious that throughout the main fire season viable seed of the season's crop is available after ground fires, and to some extent after crown fires, from cones which open on the trees after fire has passed. Even if the seeds are not ripe at the time of the fire, it is usual for many trees to die a lingering death following ground fires, thus giving opportunity for green seeds to ripen.

Unquestionably, Hofman's conclusion that seeds are stored in the duff is well based, but with large quantities originating after fire as above the burden of proof is on the investigator to prove that these do not find suitable conditions for germination, or else have a more prominent part in reproduction after fire than assigned by Hofman's article.

Regarding reproduction after cutting, it is doubtful whether investigations on areas cut 20 years ago throw much light on conditions following cuttings of today. Old cuttings used to select only the choicest trees, leaving many inferior specimens standing, as a rule. Modern cuttings take all the Douglas fir, though leaving many specimens of other species where present. It is common in areas of young growth to find many old windfalls which may have been in part the seed trees that helped in the establishment of the stand. These statements are made only in the interest of supplementary investigations to the notable ones already made by Hofman.

A further word as to the practical bearings of these investigations may be justified. The writer has maintained for several years that the cheapest method of regeneration in our overmature forests, to which cutting is confined at present, is to modify present cutting methods very little—that is, clear cut—burn the slash in a seed year for unmerchantable trees left on the ground at a time after the seed is ripe, but before it has fallen, and thus get all reproduction possible from this source, added to that along the margin of the cut-over area adjacent to standing timber. Regeneration should then be completed artificially, if necessary. These investigations seem to confirm the method, with the exception of the slash burning That has heretofore been thought necessary to permit Douglas fir to reproduce So far as fire protection goes, it would without doubt be cheaper to provide intensive patrol of slashed areas until the new growth is large enough to keep the slash damp most of the year than it is to burn slash. Slash burning is not a preventive of further fires; it only diminishes intensity. At any rate, the investigations cast extreme doubt on the advisability of leaving an investment of $5 to $20 per acre in seed trees.

B. P. K.

Natural Reproduction from Seed Stored in the Forest Floor. Journal of Agricultural Research, Vol. II, October, 1917.

Exotics in Switzerland

Badoux writes interestingly in regard to attempts to introduce exotic trees into forest plantations in Switzerland. Originally botanists and horticulturists were responsible for introducing exotics. Jussieu brought the cedar of Lebanon in 1734, the specimen persisting to date in the Jardin des plantes in Paris; Robin brought the Robinia to France in 1601, now common everywhere. Since 1890 the German foresters systematically cultivated this field, but of the many species tried so far only six have been found desirable—Douglas fir, white pine, Japanese larch, cottonwood, red oak, and black walnut.

In Switzerland, in 1861, a committee of the Swiss Foresters' Society was charged to take up this subject, but after thirteen reports the committee was dissolved for lack of interest and only personal endeavor here and there remained.

A curious move on the part of American enthusiasts in helping the movement is worth relating. After the terrible floods in 1868, the Swiss consuls in San Francisco and Washington appealed to the people of California and to the U. S. Department of Agriculture for tree seed, since "planting of forests is the only means of combating floods." The California contribution amounted to $600 worth, mostly *Pinus insignis* and *Sequoia gigantea*, but no results are on record. A park specimen of Sequoia from Canton Vaud is, however, pictured as a frontispiece, the magnificent dimensions of the 53-year-old tree being 92 feet in height and nearly 6 feet in diameter.

In spite of the apparent apathy on the question, private endeavor has established here and there small plantations, and Badoux himself planted some 500 trees of the above-mentioned conifers and poplars. Especially white pine has become a regular market article. For matches it "has beaten all the indigenous species" and is better paid; cases are cited of 60 and 75 cents a cubic foot for special material. The experience with Douglas fir, as well as Japanese larch and red oak, although only 30 to 40 years old, is equally encouraging as regards rapidity of growth.

An incidental reference to the celebrated acclimation work of Vilmorin at Barres is significant, since there in some cases, notably with Riga pine, the second generation from seed collected at the place shows itself superior in every respect to the indigenous flora.

Les essences exotiques dans la forêt suisse. Journal Forestier Suisse, February, 1918, pp. 25–31.

Larch Canker Cured

The pessimists in the matter of white-pine blister rust campaign will do well to ponder over the following account of the behavior of a—to be sure, quite different—parasite on a different host. The well-known *Pezisa willkommii* had attacked a larch plantation, now of polewood size, near Lake Geneva. The main general attack took place about 1890, and hardly 10 per cent of the trees remained immune. After a thinning in 1891, the stand had a pitiable aspect and no forester would have believed in its revival. But the thinning had a remarkable effect: Most of the trees recovered.

overgrew their wounds, and today even the stems that had been most deformed show a normal cylindrical form, every trace of deformity is gone, and nobody would guess that they had ever been mutilated.

To be sure, the technical value of the wood has suffered, for the interior wounds have left defects. The formation of wound wood over the cankerous places had progressed rapidly in some cases; in others less so; from 7 to 27 years were required to outgrow the trouble completely. The infection had taken place at various times, and the probability is that the disease was introduced into the locality with the plant material in 1864.

The rest of the article by Badoux discusses the proposition that proper silvicultural treatment, proper selection of site, and timely thinning are the means of combating the disease.

Un intéressant peuplement de mélèze à Noville, près du lac Léman. Journal Forestier Suisse, January, 1918, pp. 3–7.

UTILIZATION, MARKET, AND TECHNOLOGY

Variation in the Yield of Camphor

In a study made by Samuel C. Hood in 1907-1912 on the yield of camphor gum from trees planted in Florida, an attempt is made to furnish data that will be of value in determining the commercial possibilities of such planting. The study included a large number of tests on trees growing under varying conditions over a range of latitude of 250 miles, and was made while Mr. Hood was a member of the scientific staff of the U. S. Bureau of Plant Industry. The trees under observation were planted in hedges, in many cases serving as windbreaks for orange plantations. Samples were selected from leaves, twigs, and branches obtained during the dormant period in the winter months. The following conclusions are reached in a summary of the article:

Factors causing variation in the yield of camphor gum in commercial plantations under Florida conditions are as follows: (1) The maximum yield of camphor is secured from leaves and twigs of the last growth, taken during the dormant season. If allowed to remain on the tree through another growing season, the yield is reduced. The yield from young wood is very small and not to be considered from a commercial standpoint. (2) Severe pruning to induce a watersprout growth gives a low yield in the leaves and small twigs, while the yield of the wood so produced is very low. (3) The clipping of leaves and twigs, as in hedge trimming, tends to increase the yield of camphor in the next growth. (4) Any commercial plan of harvesting should provide a material high in yield, with a minimum amount of low-yielding wood and with least injury to the trees. (5) Even slight shade tends to decrease the percentage yield of camphor in the leaves and to reduce the leaf area of the tree. (6) A considerable yearly variation may be expected under varying climatic conditions and rainfall. (7) To a considerable extent, the yield of camphor is proportional to the rate of growth, and forcing the rate of growth of the trees will give a larger tonnage of material yielding higher in percentage of gum. (8) Higher percentages were secured on the better soils, especially those containing considerable amounts of clay. Under extreme stunted conditions of growth the percentage of camphor in the leaves may be rather high.

B. L. G.

Factors Causing Variation in the Yield of Camphor in the Florida Camphor Tree. Journal of Industrial and Engineering Chemistry, June 1, 1917, pp. 552–555.

***The** Hard and Soft Woods of Japan*

The hardwood forests of Japan produce an excellent quality of oak, ash, birch, beech, and a few other hardwoods. Oak constitutes the principal export of lumber from Japan, though a little ash (tamo and sen) and birch are also exported. All of the softwood produced in Japan is used locally. Larger sizes of softwoods are imported from the United States. Large forests of beech remain unexploited, though the rapid expansion of Japan's hardwood industry is anticipated, due to the increasing number of furniture, veneer, barrel, and other wood-working factories that are coming into Japan. Prices for hardwoods are from 10 per cent to 15 per cent lower than prices prevailing on the Pacific coast of the United States for similar material.

B. L. G.

Japan's Production of Hard and Soft Wood. Eastern Commerce, January, 1918, pp. 34–35.

Turpentine from Spruce

With the development of methods for the conversion of cymene into toluol and cumene, which can in turn be converted into tri nitro-toluol and benzoic acid, the saving of the 1,500,000 to 2,000,000 gallons of "spruce turpentine" that is annually wasted in the sulphite paper mills in the United States and Canada becomes a distinct possibility. While it has been known for some time that "spruce turpentine" or spruce resin consists largely of cymene and contains only traces of terpenes, it is only recently that research in this field has been active. A small plant for the production of toluol from "spruce turpentine" has been established in Philadelphia, but the paper manufacturers—possibly because of the profits attendant to the manufacture of paper at the present time—seem unwilling to go to the trouble to collect and ship the turpentine. It would seem to the reviewer that this difficulty might be overcome by locating such plants at or near the larger sulphite mills.

B. L. G.

Spruce Turpentine. Journal of Industrial and Engineering Chemistry, January 1, 1918, p. 4.

Motor-truck Roads

A comparatively recent development in Pacific Coast logging is the increasing use of motor-trucks. Too little attention is often given to the character of the road over which the truck must operate, simply because such machines will stand up under abuse. The best woods road is the so-called "pole road," constructed of poles, with occasional ties, to form a track for the motor-truck. Puncheon, ties (cull), or plank laid crossways are condemned as unsatisfactory and expensive roads for trucks. The cost of construction of pole roads in Washington varies from $1,500 to $1,900 per mile, exclusive of grading.

B. L. G.

West Coast Lumberman, XXXIII, February 1, 1918, p. 34.

Waste Liquor for Fuel

Recent experiments have demonstrated that waste sulphite liquor, when evaporated to dryness, is available for the generation of steam power, such fuel yielding 6,000 B. T. U.'s per pound. A pulp mill of 50 tons daily capacity must dispose of 500 tons of spent liquor, 10 per cent of which will yield organic materials available for fuel. The use of this material has been made possible through the adaption of powdered coal burning methods. The chief difficulty to overcome in the utilization of waste liquor in this manner seems to lie in the expense of evaporating such a bulk of material to dryness.

B. L. G.

Burning Fuel from Waste Liquors. Pulp and Paper Magazine of Canada, January 24, 1918, p. 70.

Fixing Wood Prices

In December, 1917, revised schedules of maximum prices for standing timber, logs, and lumber were enacted for Great Britain. The figures will be of historic value. The prices are per cubic foot Hoppus measure (whatever that may mean), with a customary allowance for bark; exceptional sizes open to contract.

Standing timber of conifers runs to 20 to 22 cents per cubic foot, except larch, which is rated as high as 33 cents; ash is the highest hardwood, with 75 cents to $1.25; good oak brings 56 to 81 cents; other hardwoods mostly 25 up to 50 cents. Ten per cent is to be added for logs cut in the woods.

For logs, free on rail, with an allowance for bark usually 7½ to 10 per cent in poplar and elm 15 per cent, the prices run: Conifers, 50 to 58 cents, except larch, up to 75 cents; that is more than double the prices for standing timber. Ash brings $1.25 to $1.87 and oak 93 cents to $1.18, except for inferior logs; other hardwoods, 62 cents to $1.

Prices for lumber are naturally more variable and run from 87 cents for common hardwood up to $5 for select ash, mostly $1 to $1.30, while conifer lumber moves within 75 cents and $1, except again larch, which runs as high as $1.12.

Railroad ties, 9 feet, 10 by 5 inches, are rated at $1.56 to $1.87, according to face.

From a statement in the *Gardeners' Chronicle* (February 2, 1918), we learn that "rough timber from the field and hedgerow" brings 50 to 62 cents per foot. In the same article further details regarding wood prices are to be found.

Home Grown Timber Prices Order, 1917. Quarterly Journal of Forestry, January, 1918, pp. 65-70.

Chemistry of Wood

A study of the chemistry of wood, with a résumé and discussion of methods of analysis and results, has recently been concluded by A. W. Schorger at the U. S. Forest Products Laboratory at Madison, Wisconsin. This study, which includes the detailed chemical analysis of longleaf pine, Douglas fir, western larch, white spruce, basswood, yellow birch, and sugar pine, is intended to furnish information of value to operators of pulp and paper mills, wood distillation plants, alcohol plants, and similar industries involving the chemical utilization of wood; for, according to the author, "the solution of the wood-waste problem appears to lie mainly along chemical lines, so that in connection with the industries already utilizing wood by chemical means a systematic survey of several typical American woods seemed essential."

In discussing the general composition of wood, Schorger seems to accept the view that lignocellulose consists of cellulose chemically combined with lignin, and doubts the assumption made by König and Rump (Chemie und Struktur der Pflanzen-Zellmembran, Berlin, 1914), who determined by experiment that the natural cell membranes consist of cutin, cellulose, and lignin in simple physical combination. As cellulose obtained from wood exhibits somewhat different reactions than cellulose from cotton, there has been some discussion concerning the proper structural formula which can be applied to wood cellulose. The difference is explained by Cross and Bevan by assigning to the wood cellulose an oxycellulose structure, though this explanation has been rejected by other investigators.

According to Schorger, the principal hemi-cellulose in wood are pentosans, $(C_5H_8O_4)_n$, though small amounts of hexosans, $(C_6H_{10}O_5)_n$, such as mannan and galactan, are frequently present. Hemi-celluloses are insoluble in water, but are soluble in dilute acids and alkalies and are more easily hydrolized by dilute acids than the true cellulose.

In a discussion of the methods of drying wood, the effect of heat upon the chemical structure of wood is given consideration. It is stated that Ost and Westhoff (Chem.-Ziet., 33 (1909), p. 197) believe that a temperature of 120° to 125° C. is necessary to expel all hygroscopic moisture, but that it is very doubtful if water retained near this temperature should be considered as merely hygroscopic. Schorger accepts the view that all hygroscopic moisture can be removed by heating at 105° to 107° C., and this method was employed as the standard of absolute dryness, as all of the analyses were necessarily based upon the dry weight of the wood. Prolonged heating at this lower temperature caused no loss in weight that could be ascribed to chemical changes in the structure of the wood, which is not in accord with the results obtained by other investigators.

In determining the volatile oil, it was found that the method of subtracting the amount of moisture found by the xylol method from the total loss in weight obtained by drying in an oven at 105° to 107° C. gives lower results than if the volatile oil is expelled by steam. The only reliable method of determining the waxes, fats, and resins was found to consist in extracting the wood with ether and weighing the extract after the evaporation of the ether. The action of alkali on hardwoods was found to be more pronounced than upon conifers. This is ascribed partly to the slight solubility of the pentosans of the conifers in alkali as compared with dilute acids.

The chief materials extracted by boiling water are tannins, bitter principles, and carbohydrates. The lignin is also partially attacked, methyl alcohol and acetic acid being formed.

"Cotton is doubtless the typical cellulose of the $(C_6H_{10}O_5)_n$ group, but it is no more reasonable to expect cotton to be the only cellulose in nature than glucose to be the only sugar. It is probable that wood celluloses should be looked upon as definite compounds of hexosans, with varying amounts of pentosans. The methoxy reaction may also be due to the presence of small amounts of methyl glucosides or similar derivatives. In this paper cellulose will be defined as the residue remaining after alternate treatment with chlorine gas and sodium sulphite up to the point where the chlorine-sulphite reaction, or the Mäule reaction, ceases."

Schorger asserts that the hardwoods can be sharply divided from the conifers by means of the pentosan content of the cellulose, and that the pentosan content of the hardwood cellulose is in general greater than that of the original wood, while in the case of conifers the reverse is true.

In determining the cellulose content of the woods under investigation, the chlorine method of Cross and Bevan was used, as it is the only method that can be satisfactorily applied to woods. It was found that conifers invariably are harder to reduce than hardwoods. The cellulose content of the various species appears to be quite uniform, especially when the cellulose is calculated on the weight of the wood free from material soluble in hot water and alcohol. In general, the conifers appear to contain more cellulose than the hardwoods, though this seems to occasionally vary greatly.

Schorger found that small amounts of acetic and formic acids appear to be present in some woods in the free state, or at least in very feeble combination. Guijo, a Philippine wood, has a marked corrosive action on metal fastenings, and an investigation disclosed the fact that about 0.2 per cent of acetic and formic acids could be leached from Guijo sawdust with cold water.

As details of the methods of analysis used in this study are fully presented, this article should be of interest and value to other investigators in the field of wood chemistry.

B. L. G.

The Chemistry of Wood, Part I, Part II. Journal of Industrial and Engineering Chemistry, June, 1917, pp. 556-566.

Forest Taxation in France

The subject of forest taxation is brought forward to show how mathematically wrong the present law taxes the yield of forests with intermittent returns, namely, simply dividing the intermittent return by the number of years (n) in the period during which is has accumulated $r = \frac{R}{n}$ instead of $\frac{R. op}{1.op^n - 1}$ and levying an annual tax on this r.

By three examples, with different rotations, it is shown that in this way an excess of 34, 59, and 507 per cent of the revenue is taxed for the 20, 30, and 100 year rotation.

In a very simple way it is shown that if the intermittent yield is changed to an annual yield, the revenue as well as the capital producing it is mixed, namely, the soil and the stock is involved as capital producing the soil rent and interest on the growing stock, and according to the different character of the capitals should be differently taxed.

It is claimed that the unfair taxation has driven out private owners from a sustained-yield management.

It is argued that after the war encouragement must be given to forest owners to recuperate the damages of the war by juster taxation.

Revue des Eaux et Forêts, October, 1917, pp. 296–301.

EDITORIAL COMMENT

Lumbermen's View on the Permanency of Our Forests

The *American Lumberman* for January 12, 1918, prints a statement which is said to embody the views of representatives of the lumber industry regarding the application of the "excess-profits" tax to that industry. The gist of the argument is that any increase in stumpage value should be regarded as an "earned surplus," and that the present stumpage value of any given tract of timber should be regarded as "invested capital," irrespective of the original purchase price. In attempting to substantiate this argument certain statements are made which, if really representative of the views of the lumber industry as a whole, are extremely significant.

After all that has been said and written during the past twenty-five years in regard to forestry and forest conservation, it is both surprising and discouraging to be informed by the chief users of the forest that "timber differs from other natural resources, such, for example, as coal and oil, in that the available supply is the total supply. The amount of it is a known quantity, and that quantity is being steadily depleted with not the slightest possibility of an increased supply from the development of new fields, as with oil. . . . The value of timber is ever upward because the demand always exceeds the supply—because the demand is always increasing, the supply always decreasing. This is the history of white-pine timber. It is the history of yellow-pine timber, and will be the history of all timber until the supply is exhausted. . . . But these (stocks and bonds, wheat, cotton, and other agricultural products, lumber, brick, and ordinary market commodities) are products of a month or a year or are crops grown this year and to be grown again next year, some subject to the control of man and others to the whims of nature, responsive to speculative influence, fluctuating and independable in supply and dependent upon an uncertain and variable demand. Timber, on the other hand, is a matured crop, grown but once and to be harvested but once, determinable in quantity, diminishing in supply, and subject to a world demand which renders it possible to estimate with reasonable accuracy the time when the supply will be practically exhausted."

It must be admitted that many lumbermen in this country have done their best to make this gloomy prophecy of a vanishing timber supply come true. Millions of acres have been stripped of their timber, burned over, and abandoned. That these areas are not today entirely barren is not due to any care bestowed upon them by their owners, but to the fact that the forest is hard to exterminate. Thanks to this fact many cut-over areas, in spite of continued neglect and abuse, are covered with a growth of some kind, which, however unsatisfactory, is sufficient proof that timber is not a crop which can be grown but once.

As a matter of fact, every school-boy knows that timber, like wheat or cotton or any other agricultural product, can be grown again and again, the only difference being that a longer period is required to bring the timber to maturity. And every forester knows that by a proper arrangement of age classes in any given forest it is entirely possible to harvest the same amount of timber year after year. In other words, there is no reason why the business of timber production should not be as stable and as permanent as the business of wheat production. The only requisite is to practice forestry.

Even if it be true that there is "not the slightest possibility of an increased supply from the development of new fields," it by no means follows that the visible supply of timber is all that the world has to depend on. Careful calculations indicate that, so far as this country is concerned, a forest area considerably less than that which we now have would, if properly managed, be sufficient to meet the real needs of the country for wood indefinitely. Not only this, but the placing of the forests on the basis of a sustained annual yield would do much to relieve the difficulties under which the lumber industry is now laboring. It would do away with the various evils resulting from the lack of permanence that has always been so characteristic of the industry; would provide a stock of thriftily growing young trees capable of meeting carrying charges and taxes; would abolish the annual depletion charge which must be met when the forest is treated as a mine; and by placing the business on a stable instead of a speculative basis would make possible the borrowing of money at a lower rate of interest.

In its editorial columns the *American Lumberman* comments that the brief filed with the Commissioner of Internal Revenue "is convincing in the thoroughness of its logic." It is to be hoped that the strange "logic" regarding the future of the timber supply does not really represent the views of lumbermen generally. If it does, the only conviction it is apt to bring to the general public is that the forests of the country are in unsafe hands, since their present guardians look upon them not as a permanent asset, but as a mine, to be depleted and then abandoned.

What a dangerous impression to convey in this era of increasing Government ownership and control!

Wood-fuel Situation

There seems little reason to doubt, optimists notwithstanding, that the coal shortage from which we have suffered this season will be intensified next season and become a real fuel famine unless the war needs cease to make their extraordinary demands.

There are only four ways in which the trouble may be avoided, or partly overcome, namely, by a greatly increased output of the mines, by a systematic, organized apportionment and delivery at places of consumption, by conservative practices in the use of coal, or, lastly, by substitute fuels. If, as the United States Fuel Controller has declared, the output at the mines was really 50,000,000 tons short this season, with its extra requirement of 100,000,000 tons, one can hardly expect that in the direction of substantially increasing the output there lies much hope, and without that the second and third methods will be of no avail; hence substitute fuels alone need to be considered.

We are naturally most interested in the proposition to return to wood fuel in order to relieve the shortage of coal, which is advocated by the conservation commissions, fuel controllers, and others, some of which agencies have gone so far as to issue bulletins suggesting practical procedures, such as the State of New York Conservation Commission, the Canadain Conservation Commission, the Fuel Administrator of North Carolina, the Federal Fuel Administrator of New England.

There are at least three major difficulties which, we must realize, will have to be overcome to make this recommendation operative. City houses are almost excluded from the use of wood fuel, not only because their heating apparatus is not fit for that fuel, but, even if it could be made to use it, there is, as a rule, hardly space enough to store the necessary cordage. While theoretically a cord of wood is to produce the heating effect of one ton of coal, as some of the advocates of this substitute have claimed, practically it can be asserted that this proposition will rarely hold, if for no other reason (such as the difficulty of keeping a wood fire fed), because wood is rarely, or should we say never, seasoned, if, as it would have to be, it is stored in the yard. A simple two or three story city house, which in our northern climate might get along with twelve tons of coal for the season for heating purposes and another eight to ten tons for cooking purposes, would require not less than 50 cords, or around 2,000 square feet of yard room. Of course, it is not expected that the full fuel requirement would be changed to wood, and, if obtainable, wood may be used even in city houses to eke out coal supply, but not without considerable friction.

The next difficulty is to get the wood out *now*, so as to be seasoned and available next winter. We are afraid that unless some very determined effort is made by officers in charge to start the wood-chopping campaign not much headway will be made voluntarily, especially in view of the shortage of labor in the country.

But the third difficulty is the most serious and can only be overcome by a very determined initiative and procedure on the part of the authorities. We must realize that the substitution of wood is an emergency measure, and when the emergency is passed we shall return to allegiance to King Coal. The passing of the emergency is most uncertain. If the war should end abruptly, the munition factories come to an end, the coal requirement become normal, what would become of the accumulated wood supply? Who will dare to speculate on such premises? We come here to the main point of our discussion, namely, that we may not expect that by mere "encouragement" of the farmer or the wood merchant we will induce him to take the risk of stocking the market with a material that may suddenly get out of fashion. Only a guarantee of fair prices and against loss will be an inducement to go into such business, and such guarantee must come from authoritative quarters. Whatever may be done in the rural communities individually for self-protection, for municipal corporations it will be incumbent to make contracts with producers of wood to supply the citizens as needed, on a co-operative plan, with the fuel, and guarantee that the municipality will be good for any surplus, when the loss may be made good by taxation and charged off as an insurance fund. If there be properly constituted fuel controllers, it is up to them to become active at once in formulating and pressing to adoption some such plan.

We are, however, not sanguine enough to expect such foresight on the part of our particular corporation, and for ourselves personally have in mind the investment of oil-stoves as on the whole probably more practical.

The contemplation of the possibility of a return to wood fires recalls to the writer that some thirty years ago he inveighed at the faulty construction of wood stoves and developed the philosophy of the wood fire, which might be of some value to would-be wood users, and for their benefit we briefly recall the statement.

The philosophy of laying a wood fire is based on the fact that it is not the wood that burns, but the gases developed from it; hence, in order to utilize the heat to best advantage, the wood should be laid in the direction of the draft and not, as in open fireplaces and many makes of wood stoves, so as to have the draft across the pieces. If laid according to our prescription, the draft and the flame progress lengthwise to the fuel; its heat evaporates first the water always present in wood and then gasifies the fuel, and thus the best service is obtained—a complete consumption without the need of rearrangement.

In starting the fire, three pieces laid lengthwise, so as to form channels for the draft, is best practice. In a properly constructed stove, where the draft works along the fuel, it is possible to keep in a wood fire over night by lighting the billets at one end and then reverse them, so that the fire will have to slowly burn in opposite direction of the draft.

B. E. F.

NOTES

Woodlands Section of Canadian Pulp and Paper Association[1]

At the organization meeting of the new Woodlands Section of the Canadian Pulp and Paper Association, held late in November, at Montreal, interesting addresses were made by Messrs. Ellwood Wilson, the prime mover; A. B. Recknagel, forester to the Empire State Forest Products Association; R. H. Campbell, director of the Dominion Forestry Branch, and Gustave C. Piché, Chief Forester for the Province of Quebec.

Mr. Wilson spoke of the importance to nations of forests for defense and offense, as shown by the use made of their timber wealth by Germany and France. The problem presented to the pulp and paper industry is a question of raw material. The sensible way is to face the problem now and study and plan in advance of necessity.

Mr. Recknagel spoke on "The Empire State Forest Products Association and its Work." He referred to the inventory of land and developments controlled by that association which gave the basis for the forestry work. This forestry work is very diversified and many problems present themselves. Of these, utilization is perhaps the foremost. Forestry starts with complete utilization of all the mature, ripe timber, proper disposal of brush, the safeguarding from fire, and the assuring of reproduction. This involves a careful study of logging and market conditions and accurate cost data. Here the woodlands section of an association can be of great help in standardizing the available data and causing studies to be made bearing on the problems at hand.

Next is the large field of silviculture. There is need for standardization, for a bringing together of facts, a discussing of methods and results, for which the woodlands section will serve admirably as a clearing-house. The same is true of fire protection.

Then the economic problems of taxation and legislation. The Forest Products Association is working to secure proper legislation for the tax relief of those planning to hold their land for repeated crops. (Such a bill was introduced into the New York legislature on January 23.)

[1] *Pulp and Paper Magazine of Canada.* November 29, 1917. Pp. 1105–1109.

Publicity and education follow in sequence. In each of these fields concerted effort will produce results that individuals cannot hope to attain.

Finally, there is research by co-operating with the established Government agencies; the needs of each can best be correlated.

Mr. Campbell, representing the Dominion Government, spoke of the fundamental value of the pulp and paper industry and the public necessity to back it up. Therefore the Government should be interested in the future supply of raw material to the industry.

We, too, can improve the condition and output of our forests. It requires men who know conditions and who are in the forest.

Finally, Mr. Piché made the real forestry appeal of the day. After complimenting the pulp and paper industry on their energy and efficiency, he continued in a less complimentary vein: "It is very sensible," he said, "to improve your fabrication; but why would you leave your forests, your source of raw meaterial, in a bad state? Why not apply the same methods of scientific management that you employ successfully in your mill for the production of your timber supply: why leave your forest operations in the hands of jobbers, who have only a vicarious interest, instead of employing technical men, as you do in your mills? The pulp and paper industry, being established for a long time, can afford to manage its forests on a permanent basis better than any other class of lumbermen."

Mr. Piché then outlined the program to be followed:

(1) Secure the proper man to put in charge of your timber lands—a forester.

(2) Make an inventory of your timber lands. The operations, to be conducted in an efficient manner, must be directed by the head office according to a working plan and not be carried on in a haphazard way, as done now.

(3) Studies of the rate of growth of the various species, so as to know how they should be cut.

(4) Reforestation: A mill producing 100 tons per day would only require a forest area of 200,000 acres if same was managed to produce wood properly. By adding $1 more to the cost price of your wood, you could reforest enough land each year to insure you a permanent supply for the future.

Other speakers at the meeting were: Col. J. B. White, who is in charge of forestry work for the army in France, and Senator Edwards. The former drew a "deadly parallel" between the productive forests of France and the unproductive ones of Canada. The latter urged that any further co-operation that can be carried out should be effected, as today the lumberman is working under the worst conditions possible.

Above have been briefed the addresses made at a meeting of the Canadian Pulp and Paper Association in Montreal on November 23, 1917, looking to the formation of a forestry or woodlands section. At this meeting Messrs. Ellwood Wilson, of the Laurentide Company; Walter N. Kernan, of the Donnacona Paper Company, and Angus B. McLean, of the Bathurst Lumber Company, were appointed a committee to draft a constitution and organize a section. The object of this section is to bring together the men who are actively handling the work in the woods and for interchange of ideas, the study of better and more economical methods of getting raw material to the mills, and the problems of utilization, which are demanding attention and on whose solution future supply depends.

This is a distinct forward step and shows the initiative of the association. The American Pulp and Paper Association would do well to consider taking similar action.

The by-laws of the Woodlands Section provide:

Two classes of members: (1) Members—entitled to vote; (2) associate members—not entitled to vote.

1. *Qualification for Members.*—Any person who occupies, or has occupied, an executive woodlands position in the pulp, paper, and lumber industry; any one occupying a subordinate position in the pulp and paper industry who has had a satisfactory technical education; any one who, though not having had a technical education, has special qualifications and experience.

2. *Qualifications for Associate Member.*—Any person who will support and assist the aims of the Woodlands Section and who, by virtue of his qualifications, is likely to further the work of the section. These members may attend all official meetings of the section and have the right to take part in discussion.

Any associate member who in the opinion of the council satisfies the requirements of Class 1 may become a voting member.

The annual dues for voting members shall be $3, and the annual dues for associate members $2, payable at the beginning of the calendar year. A member who has not paid at the end of the year is suspended.

A council of five members is to manage the business of the section, and besides the annual meeting two other meetings during the year are to be provided for.

A. B. R.

Resolutions Adopted by New York State Forestry Association

Among the resolutions adopted at the sixth annual meeting of the New York State Forestry Association at Albany, N. Y., on January 22, 1918, were two which have already borne fruit. The first was a resolution "that steps be taken to amend Article 7, Section 7, of the Constitution, so that the prohibition of Section 7 shall not prevent the cutting or removal, under proper restrictions, of trees that may be needed to supply fuel for domestic use, nor prevent the construction of roads and trails necessary for protection against fire and for ingress and egress."

The second resolution, based upon the accepted report of the Committee on Forest Taxation, of which Mr. Geo. N. Ostrander, President of the Empire State Forest Products Association, is chairman, on a measure to provide a yield tax for lands devoted to continuous forest production, was that the Forestry Association "bend its energies to the enactment of the proposed measure, and that all organizations and agencies in the State of New York and throughout the country which are engaged in fostering forest management in the State be urged to join with it to secure the desired legislation."

Acting upon the first of these resolutions, a concurrent resolution has been introduced in the legislature by Senator James A. Emerson, of the 33d District, and Assemblyman Raymond T. Kenyon, of Essex, amending the Constitution to allow the taking of trees for domestic fuel from the State Forest Preserve and permitting the construction of necessary roads and trails in the State Forest Preserve.

Similarly, the proposed forest-tax legislation has been introduced and has been referred to the respective committees concerned.

These two measures mark a distinct forward step in regard to the handling of our forest resources. The New York State Forestry Association is to be commended for such a constructive policy, as are also the other organizations and agencies in the State which are engaged in fostering forest management and which have been working with the State Forestry Association to secure these results.

Campaign for Increasing the Use of Wood as Fuel

The campaign for increasing the use of wood as fuel, that for the past few months has been actively conducted in most of the States in the central and eastern part of the country, is beginning to bear fruit The scarcity of coal everywhere has forcibily turned the attention of the public to the use of substitutes, and in that it is the opinion of many of those in a position to know —State fuel administrators and others that the coal shortage will probably be quite as serious next winter as it is this, active steps are being taken in a large number of States to meet the emergency by largely increasing the cut of fuel wood this winter.

Among the State publications that have been issued as a part of this movement are especially to be noted Extension Circular 22 of the New Hampshire College, "Firewood," by K. W. Woodward; Circular 79, Office of the Secretary, U. S. Department of Agricutlure, "Emergency Fuel from the Farm Woodland," by A. F. Hawes; Department of Conservation and Development, New Jersey, "Wood Fuel," by R. D. Forbes; Office of the State Forester of Massachusetts, "Wood Fuel," by Paul D. Kneeland, and an article in *Conservation*, the monthly bulletin of the Canadian Commission of Conservation, for February, 1918, by Clyde Leavitt. The U. S. Forest Service has established a special news service dealing with this matter, under the direction of E. R. Hodson.

Study of Red Pine

The first steps in a much-needed study of red pine[1] in the Northeastern States have been taken by a co-operative arrangement between the Department of Forestry of Cornell University and the Empire State Forest Products Association. Despite the inclement winter, field-work was begun in January at Au Sable Forks, in the eastern foothills of the Adirondacks. Assistance was furnished by H. R. Bristol, of the Delaware & Hudson Company (Northern New York Development Company). The work was under the direction of Prof. B. A. Chandler, of Cornell University.

The first fruits of this study show a less favorable growth of red pine than had been anticipated. The results are given in the accompanying table. This may be due to purely local conditions of poor site and overcrowded stand; on the other hand, it may be due to inherent slowness of growth of red pine after reaching merchantable diameter. The uncertainty as to which of these reasons is the cause of this slow growth gives additional emphasis to the need of studying the growth of this species. The red pine has come to be regarded as a substitute for white pine; it is commonly recommended for planting in mixture with, or even in place of, white pine. No adequate basis of knowledge exists for any such recommendations.

This study will be continued during the field season, and when completed the results will be published by Cornell University. It should be clearly understood that the data presented herewith are of preliminary character only and designed to stimulate interest in a very important investigation.

[1] See article on "The Growth of Red Pine" in Ontario. *For. Quarterly*, Vol. XI, pp. 160–171.

Empirical Yield Data on Red Pine (Pinus resinosa), Second Growth

Taken at Au Sable Forks, New York, January, 1918, by Prof. B. A. Chandler, Cornell University, in Co-operation with Empire State Forest Products Association, and Particularly the Northern New York Development Company

No. of plot.	Age (years).	Height of dominant trees (ft.)	D. B. H. Average trees, inches.		Number of trees per acre.				Volume per acre red pine, cubic feet (exclusive of bark).			Mean annual increment per acre, cubic feet.	Basal area per acre, square feet (red pine, crown class 1).	Remarks. (Details on forest description sheets.)
					Red pine.		White pine.	Pitch pine.						
			Crown class 1.	Crown class 2.	Crown class 1.	Crown class 2.	All classes	All classes	Crown class 1.	Crown class 2.	Total.			
1	67	53	8.8	7.0	224	128	...	...	2,069	602	2,671	40.0	94,244	Age is that on stump. Stump .3 foot high. Height is total incl. stump. Based on 1/8 acre. Age based on dom. trees.
2	68	61	11.3	7.6	168	40	160	...	3,168	327	3,495	51.4	118,400	Age is that on stump. Stump .1 foot high. Height is total incl. stump. Based on 1/8 acre. Age based on dom. trees.
3	55	58	8.3	6.0	212	104	52	120	1,972	378	2,350	42.7	78,592	Age is that on stump. Stump .2 foot high. Height is total incl. stump. Based on 1/4 acre. Age based on dom. trees.
4	69	65	11.7	8.2	100	64	56	2	2,097	541	2,638	38.2	74,840	Age is that on stump. Stump .1 foot high. Height is total incl. stump. Based on 1/2 acre. Age based on dom. trees.
5	69	60	9.5	7.6	228	176	...	...	3,062	1,393	4,455	64.6	110,988	Age is that on stump. Stump .3 foot high. Height is total incl. stump. Based on 1/4 acre. Age based on dom. trees.

Crown class 1 = trees of superior crown development—dominant trees. Crown class 2 = trees of inferior crown development, due to overcrowding.

Converting factors: 1 cubic foot = 5 to 5½ board feet. 1 cord (4 x 4 x 8) = 85 to 90 cubic feet.

"Honorable mention" should not be withheld from the admirable, aggressive peace work of the secretary of the Canadian Forestry Association, Mr. Robson Black, who, in spite of the distractions of the war, is carrying on a most active educational propaganda with all the means which an accomplished, active newspaper man can command. He does not only keep the newspapers supplied by liberal sending out of cartoons, pictures, and articles, by giving free lectures through the country towns, by tackling boards of trade and other public bodies, but he is doing, what most secretaries neglect—he is keeping his directors continuously informed of what he is doing and what is going on. Nay, if a definite proposition, as a legislative amendment to the prairie and forest fires act in Alberta, is under discussion, he keeps the 700 Alberta members stirred up with follow-up literature, so that they feel their active participation in the association's work and exercise their membership function.

From the secretary's report to the directors of the association, submitted at the meeting of the Association and Conference on Forest Problems, held February 6, 7, and 8, 1918, at Montreal, we learn that the public-meeting method of publicity is most favored, some 32 such meetings having been held, the secretary's mileage being in excess of 17,000. Other speakers, both English and French, with illustrated lectures, are employed; school teachers are engaged to talk on forestry subjects and are supplied with material, and printed literature of all kinds is disseminated. Legislators and ministers have been interviewed as regards permit systems for setting fires in clearing lands, the abolition of the patronage system, the organization of a New Brunswick forest service, etc.—an endless variety of activities has characterized the work of the year.

We advise all those who are engaged in similar propagandist work to watch the secretary of the Canadian Forestry Association.

An article on the Arnold Arboretum and its work in the Chicago *Post* of November 26 contains the following interesting statement regarding Norway spruce: "Professor Sargent writes: 'Western China alone has furnished the arboretum with more species of spruce trees than were known twenty years ago in the whole world.' Some of these, because of the climatic relations, may be expected to take the place of the Norway spruce, now unfortunately largely planted in the United States, though Professor Sargent long since pointed out that it could not become a permanently satisfactory tree here because of its origin in the lower temperature range of Europe."

Ellwood Wilson recently cut some white spruce (*Picea canadensis*) near Proulx, Quebec, in natural, second-growth stands, which showed remarkably rapid development. One tree, said by him to be typical, measured 12.05 inches in diameter outside bark at 18 inches above the ground. The age of this tree was 29 years, the height 40 feet, the merchantable length 30 feet. It takes 9.4 such trees to make a cord of pulpwood. The current annual increment (c. a. i.) of such a tree is 45 cubic feet. The tree was growing on sandy soil, not on a particularly good site.

The United States Supreme Court on June 7, 1917, decided the case of the Milwaukee Railroad against the United States. When the railroad was built through the St. Joe Forest, about ten years ago, the Forest Service made the usual requirements that timber cut along the right-of-way must be paid for, and that the railroad must sign certain stipulations to protect National Forest interests. The company refused to do either one and the case has been pending in the courts ever since.

On October 13, 1917, the railroad deposited in the Western Montana National Bank the sum of $89,264 in payment of damages, itemized as follows:

Mature timber cut on right-of-way and adjacent widths	$26,989.00
Mature timber burned during construction	12,000.00
Immature timber burned during construction	24,000.00
Damages for obstruction of navigation of streams	5,500.00
Interest at 7 per cent from June 11, 1913, to October 11, 1917	20,775.00
	$89,264.00

J. F. P.

Pennsylvania's Commissioner of Forestry, Robert S. Conklin, announces that no limit will be set this year on the number of forest-tree seedlings for free distribution. Any one who wants to plant trees next spring may have them for the asking, the only conditions being that applications for less than 500 trees will not be filled, that applicants must pay for packing and transportation, and that the trees must be planted in Pennsylvania for reforestation. Over 10 million trees are ready to set out next spring. The stock is almost all three years old, and includes white pine, Scotch pine, red pine, pitch pine, Norway spruce, European larch, Japanese larch, and red oak. It is reported to be of better quality than any sent out last year.

War Salaries for Swedish Foresters

Because of conditions due to the war, members of the Swedish Forest Service have during the past year (1917), in common with other State employees, been receiving a 15 per cent increase in their usual salaries. In addition to this, assistance is also given to those having a wife and children under 15 years old to support, the extent of the assistance varying in accordance with the amount of their income and property tax. For the year 1918 additional salaries, varying from about $50 to $100 a year, have been provided for the lower grades in the State Forest personnel.

Most of the trade journals report fully on the transactions of the Ninth Annual Pacific Logging Congress, held at Seattle, Washington, October 18, 19, and 20, 1917. Besides food conservation, the elimination of waste, and economy in the management of the cook-house, which occupy prominent places in the discussion, papers were presented on gasoline locomotives, powdered coal for fuel, location and construction of logging railroads, bridge construction, the relation of forest schools to the lumber industry, etc. It is gratifying to note that forestry and logging engineering are commanding more and more attention from the lumbermen as the years go by.

At a meeting of the Canadian Society of Forest Engineers, held at Ottawa on November 27, resolutions were adopted having reference to the proposed Forestry Branch in New Brunswick. An advisory board of five members is suggested, the Minister of Lands, Forests, and Mines to be chairman, with the Deputy Minister, a technically trained chief of forests, and two lumber or pulp mill men; appointments to this service to be supplied through an examining board. The permit system for setting our fires and other fire legislation, including enforced slash burning at the discretion of the Government, were recommended.

An investigation of the wood-fuel situation in Indiana by the State Board of Forestry shows that with chestnut hard coal at $9.63 a ton, wood at $2.52 per rick of 8 by 4 feet by 16 to 22 inches, and assuming a fuel value of one ton of coal equal to a cord of wood, the latter is cheaper than the coal. It is claimed that the woodlot owner could realize from $5 to $12 per day for his labor and team and at the same time improve his woodlot.

The *Canada Lumberman and Woodworker* for November 15, 1917, is a "shipbuilding number" and includes several very interesting articles on the building of wooden ships—a trade that has been revived by war conditions. The articles are well illustrated, and after reading and studying these pictures one realizes why it is that shipbuilding is such a slow, tedious process.

City Foresters Wanted

Two more cities have recently taken action to secure city foresters. These are Milwaukee and Racine, Wisconsin. The work in both cases is to be under the Board of Park Commissioners, and men with the necessary technical training and practical experience are wanted. Executive ability and a high degree of tact and firmness are also regarded as necessary qualities, in order to handle the work efficiently and to secure the co-operation of the general public. Foresters desiring to apply for the position should write directly to the Board of Park Commissioners in the city concerned.

It is refreshing to learn that in spite of the troublous times in the world at large, and not least in China, the forestry propaganda in that flood-scarred country has not been allowed to wane. Indeed, the terrible flood of the year in the Province of Chihli, which made tens of thousands of people homeless, was a persuasive supplement to the propagandists' work.

D. Y. Lin (Yale), professor of forestry in the University of Nanking, writes not only of his activity in popular education, but of his success in enlisting prominent officials to take up the subject practically, among them: "Ex-President Li Yuen-hung and ex-Premier Hsiung Hsi-ling, who is director general of relief work. Ex-President Li has decided to start a demonstration forest in Nanking first and later on in Hupeh and Chihli, using his own money. Mr. Hsiung Hsi-ling, although busy all the time with his many important duties, is going to send men to investigate the headwaters of the five Chihli rivers which have caused the annual floods, and it is our hope that after the investigation he will establish some form of permanent forest board for Chihli, to the end that the amelioration of the five rivers may be permanently effected."

One of the most interesting substitutes which the war has provoked is the use of sphagnum moss for wound dressing. A special committee on sphagnum dressing has been at work in Canada and the Hospital Dressings Department of the American Red Cross Society in the United States to test the value and develop the methods of using the moss. It appears that there is great variety in the raw material, and that so far as tested the moss to be found on the Pacific coast, and somewhat less satisfactory on the Atlantic coast of the United States, is of superior character for this use, that of the interior bogs less so. The moss obtained from the maritime provinces and Newfoundland is of the highest grade. It is also found that the muslin bags used to contain the dressing are best replaced by a new paper tissue of unusual firmness which does not, as the muslin, retard the absorbing capacity of the dressing. A large amount of sphagnum dressings will presently be manufactured.

It is only fitting to make it known to our readers that the laborious work of compiling the terms used in the logging and lumber industries, which we printed in the first issue of the JOURNAL of the present year, is entirely to be credited to Prof. R. C. Bryant, of Yale Forest School. It is, of course, possible, and indeed probable, with such a large amount of terms, that omissions or even mistakes should occur. Any of our readers finding such will perform a favor by advising Professor Bryant directly.

The Connecticut Agricultural Experiment Station publishes a handy bulletin (No. 199), combined with a calendar, giving brief directions for preparing insecticides and fungicides and their use on cultivated plants, including trees.

One of the pioneers of the early forestry propaganda in the United States, Col. Edgar T. Ensign, died at the ripe age of 79 years in Colorado Springs, Colo., on February 15. Colonel Ensign—the title was earned for gallant service in the Civil War—was originally a lawyer, afterward a banker, coming in 1874 from Iowa to Colorado.

The State, admitted to statehood in 1876, is perhaps the only one that in its constitution provides for a forest policy, and Colonel Ensign was among the first to attempt to have the State committed to a practical application of the policy. He became the first State Commissioner of Forestry and served with singular devotion through political troubles, part of the time without salary, trying especially to work out a plan for protection from fire.

In 1887 he was appointed special agent of the Division of Forestry in the U. S. Department of Agriculture to study the forest conditions of the Rocky Mountains. The result of his labors was printed as part of Bulletin 2 of the Forestry Division, in 1889, for the first time giving a detailed account of forest conditions over such a large area. He was also instrumental in organizing the State Forestry Association, and altogether was the representative of forestry propaganda in the State, although in later years less actively so.

His friends will remember him as a sincere and thorough gentleman.

New York Section of the Society of American Foresters

At a meeting held at Utica, N. Y., on March 13, a new section of the Society was organized, to be known as the New York Section, of which Mr. C. R. Pettis was elected chairman and Mr. A. B. Recknagel secretary. The following members were present to organize the section:

Ralph S. Hosmer, Cornell University
W. G. Howard, Conservation Commission
A. S. Hopkins, Conservation Commission
R. S. Kellogg, New York City
S. N. Spring, Cornell University
B. A. Chandler, Cornell University
J. E. Rothery, New York City
J. W. Stephen, N. Y. State College of Forestry
John Bentley, Jr., Cornell University
F. F. Moon, N. Y. State College of Forestry
E. F. McCarthy, N. Y. State College of Forestry
A. B. Recknagel, Empire State Forest Products Ass'n
C. D. Howe (guest), University of Toronto

The by-laws, which had been drawn up by Mr. Howard and Mr. Gaylord, were unanimously adopted. Two regular meetings a year are planned: one during the summer months and one in the winter, with such special meetings as may be necessary from time to time as important forestry problems arise. It is a matter of considerable encouragement to the entire membership of the Society that a new section can be organized at this time, and particularly one in New York State, which will give the foresters there an opportunity to wield considerable influence throughout the country.

Errata

In the last issue of the Journal the article entitled "Forestation Practice in Norway," based on "Om Barrträdskultural i Norrland," was wrongly attributed to Norway. It should have been attributed to Sweden. Norrland is a province in northern Sweden, while Norje in Swedish literature refers to the country Norway.

SOCIETY AFFAIRS

In the election for the rank of Fellow, which closed on February 15, in accordance with the provisions in the revised constitution, six members of the Society were raised to that rank, as follows:

	Number of votes		Number of votes
Gifford Pinchot	175	Filibert Roth	161
H. S. Graves	174	Raphael Zon	157
B. E. Fernow	172	W. B. Greeley	140

Total number of votes cast 177

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Vol. XVI APRIL, 1918 No. 4

THE TECHNICAL MAN'S SHORTCOMINGS

By Richard H. Boerker

It seems to me that Kneipp's article in the February issue of the Journal accomplishes but one thing, namely, to stir up the old quarrel between the so-called practical man and the technical man. If he had, in addition to enumerating the technical forester's multitudinous shortcomings, offered a few suggestions as to how the latter might better fit himself for his position, we might peruse the paper with a little more indulgence. I have taken particular pains to note any helpful suggestions which might remedy the situation, but have found none. I am ready to admit that the technical foresters have their share of faults, because I am one myself; but few of us will admit that the situation is as overdrawn as Kneipp makes it. I would like to ask Kneipp: What are you going to suggest to remedy the situation? Where does the trouble lie? Whose fault is it—the man, the forestry school, or the Forest Service? It is a very easy matter to find fault; quite another to offer constructive suggestions.

There are two courses open to us, just as in the case of the sick horse. We can carefully diagnose the disease and apply the remedy, or we can get rid of the case forthwith by cutting the animal's throat. In other words, we can either carefully diagnose the technical man's troubles or we can abolish his position altogether. If we take the former alternative we may look for the trouble in three different places. We must accept one or more of these three premises:

1. The forestry schools are not giving the right kind of training.

2. The Forest Service is unreasonable in its requirements from the technical man.

3. The forestry schools do not get the right kind of men to start with.

Kneipp makes three major points in his article, namely: (1) That there has been an actual decrease in the number of technical men during the last 10 years; (2) that technical men have not shown as marked advancement and have not been as successful as might be; (3) that our technical forestry graduates fall short in many so-called practical, every-day features of forest management and in the matter of mental and physical adjustment to their new environment.

His first two points can only be proved by a tabulation of statistics.

His position regarding the third item shows a rather narrow viewpoint, both in what forest management consists of and in what a technically trained forester should know. On the whole, it brings up the old controversy, settled more than a hundred years ago, of the relative merits of the practical man and the scientific man.

Was not forest management in Germany and other countries held back for hundreds of years while it was in the hands of these so-called practical men? From the twelfth to the close of the eighteenth century forest management advanced so far, and no further, until the technical forester came upon the scene.

The situation at the end of the eighteenth century was, briefly, this: Forest management had developed largely in the hands of the Cameralists, who were usually at the heads of the forest administrations, and in the hands of the so-called "Holzgerechte Jaeger," to whom, naturally, fell the work in the woods. Under the Cameralistic régime technical forestry work was held back because these men, while well informed in financial, legal, and administrative matters pertaining to the forest, were rather ignorant of natural science and technical forestry. The hunters, who were also supposed to be versed in forestry matters, had had no schooling in the science of forestry, but usually possessed a great fund of practical knowledge gleaned through years of experience in the woods. At the beginning of the nineteenth century a new order of things came into being. Technical foresters began to supplant the practical foresters and made possible the present high stage of development of the science.

The transition stage which took place in Germany about a century ago is, in its major aspects, identical with the stage American forestry is now passing through. When the field force of the Bureau of Forestry was first organized, in 1897, men who were well informed in administrative matters connected with the National Forests secured most of the administrative positions. This condition of affairs continued for almost 10 years. Beginning about 1900, technical foresters began to come from the forestry schools. These are gradually and certainly displacing the old type of man. It will be a long transition, but the outcome is inevitable, judging from forestry history. Why? Because forest management in its large aspects demands technical training, and because, furthermore, all professions and all vocations that have to do with applied science absolutely require a scientific personnel to carry on the work.

Coming down to present conditions upon our National Forests relative to our technical men and analyzing the situation from the standpoint of the school, the Service, and the man: The first premise was that the forestry schools were not giving the right kind of training. Kneipp says that there are lots of things which the embryo forester should know, but which he does not know when he takes his position. Besides silvicultural management and other things which he learns in school, he says there are many more important things which he does not learn in school, such as matters connected with fire protection, the construction of improvements, the management of human affairs, the land laws, the grazing business, regulations, personnel, and organization. Is this not the case with almost any profession one might choose to name, as Professor Spring has pointed out? Doubtless the new technical forester has some of the fundamental principles in these matters. If he is the right kind he can acquire the details as he goes along.

It is important to give all possible credit to the forestry schools for what they have done. The technical position is a relatively new one and the forestry courses are also new. Both are in the process of development and improvement. The position ten years ago made very few demands compared with the large number of different demands it makes today. Forestry courses are constantly changing to meet these demands. Ten years ago who of us dreamed of forest investigations, of land classification, of logging engineering, of forest engineering, and a host of other matters now so important? And, to my knowledge, most of the forestry schools have been making constant changes in their curricula to meet these new demands. The result of this process is that each crop of technical foresters is better equipped than the one before.

It is also important to realize that all that the forestry schools can do is to teach general principles and point out the right road to travel. They have neither the time, the facilities, nor the means to hire the instructor to teach the prospective forester the many diversified things which he must know for his work on the National Forests. Forest schools do not pretend to turn out foresters; they turn out men who have certain tools and equipment, which if properly used in connection with certain important personal qualifications will gradually make foresters. Therefore, as in all professions, vocations, and trades, some men, no matter what their training, are bound not to find the work congenial. It is not within the scope of the forestry school to say who shall be a forester and who shall not.

The next premise which we have made is that the Forest Service is unreasonable in its demands upon the technical man; in other words, that the Forest Service expects more from him than it is within the power of the school to give him. Judging from Kneipp's article, the reader might infer that there is no limit to what the Service is expecting from the new man in his first ten years out of school. I dare say that there is no forester today, no matter what his position, who lives up to half of the requirements set down by Kneipp.

While, theoretically, it would be highly desirable to have foresters who possess all these attributes, practically the proposition falls through because of that omnipresent stumbling block—human nature. Men have their likes and dislikes, their hobbies, their inclinations, etc.; all of us cannot like all jobs equally well nor do them equally well. And I think that most of the officials in the Service recognize these human traits. Therefore I do not believe that the Service is expecting a more diverse education than the school can give.

The fact is that the job has outgrown both the technical forester and the school. They are trying to catch up, and they are meeting with considerable success. Therefore what ignorance the technical man has displayed in certain matters on the National Forests is due not so much to his own shortcomings as to the inherent difficulties of the new job. He is a pioneer who comes equipped with ideals. When he meets the realities he finds that he must, temporarily, lay aside some of his tools, but still have them handy when circumstances demand their use. He comes equipped with a wood-carver's chisel; he must lay this aside temporarily and learn the use of the cross-cut saw and the broad ax. As soon as he has cut off the corners and excess material he finds his work before him in the rough. He then starts the details with his chisel. At present the crude pioneer, "cross-cut saw and broad-ax" conditions on the National Forests favor the practical woodsmen who have had experience in this kind of work and life; with the advent of more intensive forestry, conditions are bound to become the reverse—that is, they will not only favor the technical man, with the wood-carver's chisel, but they will absolutely demand a man of his training and ability. We are passing through a transition stage in which the technical man, in the face of great and many difficulties, is gradually coming into his own.

One would naturally infer from what I have said about the school and the Service that the fault must therefore lie with the man, namely, that the schools do not get the right kind of man to start with. This is only partly true.

To begin with, the situation is this: (1) A technical forester is required for a position which demands a great variety of practical, scientific, social, temperamental, and other qualifications; (2) the schools of forestry take men of varying dispositions and temperaments and make embryo foresters out of them; (3) now, (1) may coincide in every respect with (2), but in 99 cases out of 100 it does not, due to the great variations in human nature. But, no matter whether (1) coincides with (2) or not, the Forest Service must try to fit the man to the job and the job to the man.

In most cases, therefore, it may be taken for granted that when a technical man does not succeed it is due to dispositional or temperamental characters and principally to a lack of flexibility to meet new conditions. This lack of mental and physical readjustment to the new environment is not due to any lack of training by the school, but to an inborn inability to adapt one's self to new and changing conditions. The new conditions of climate, customs, manners, people, and what-not are the conditions of the West as distinct from those which obtain in the East. And this, to my mind, is where most of the technical foresters have fallen down. But this is not due to the school, the Service, or the man, for who will say that only Western men shall be allowed to fill positions in the West? Where the fault lies is hard to say; it is merely one of the non-ratable factors which appears in all new enterprises and undertakings. I look for the matter to work itself out. And it is doing that very thing today. Foresters are gradually gravitating back to their old environments and practicing forestry where the conditions suit them. I look for the forest examiner of the near future to come more and more from the environment in which he is to do his work. He will have a great advantage over the city-bred Easterner, because he will feel at home in the pioneer conditions of the West. Thus will be eliminated many of the social and temperamental shortcomings ascribed to the present generation of technical men. It is a great sifting-out process, and it is bound to continue so for many years, because forestry is still in an embryonic condition—it is constantly developing and evolving.

Then comes the question: Are the higher administrative men doing their share to develop these embryo foresters after they get them? They need more than to be reminded of their shortcomings. In order to give the prospective technical forester greater familiarity with forest administration as it works out under Western conditions, it may be desirable for the Forest Service to require him to serve one or two years as a district forest ranger before he can become eligible for the position of forest assistant, which would then be attained by means of a promotion examination.

I would, therefore, say to men like Kneipp: Take a broad-gauge view of the situation and remember what there was to start with 20 years ago. The conditions under which the schools, the Service, and the men are laboring are extraordinary and all are undergoing a process of evolution. About 25 years hence we may have the ideal technical forester which Kneipp speaks of. It is a healthy sign that the embryo forester has lots to learn when he gets to his new assignment, and, considering the many and new variable factors involved both in the man and in the job, it is truly a miracle that so many technical foresters have made good.

CONCERNING SITE

By Carlos G. Bates

Forest Examiner, Fremont Experiment Station

The only final criterion of site quality is the current annual cubic-foot increment of a fully stocked stand of the species under consideration.

Any other criterion of site quality is a compromise or makeshift which, of course, may be justified under many circumstances.

In talking about the increment criterion of site quality the writer is distinctly not discussing makeshifts or temporary expedients, but rather an actual standard of site qualities which, because it is exact and contains the smallest possible element of human judgment, may now begin to be and remain forever the standard of American foresters in all descriptive writing, in working plans, etc. It is believed that the Forest Service and other agencies now possess abundant data on the growth and increment of all the more important American species, so that the range of productiveness of each species could quite certainly be determined and standards could be fixed which would thenceforth mean the same thing to all. Suppose, for example, the increments of white pine under all known conditions were found to run from 10 cubic feet per annum to 210 cubic feet. Then, assuming that for the whole of North America it is desirable to recognize five degrees of productiveness of land, in terms of white pine, with those limitations fixed, there could thereafter be no excuse for calling 100-cubic-foot land anything but "White Pine Site Quality III," and "White Pine Site Quality III," no matter by whom the expression was used, or to what region it was referred, or to what topographic position, would to each of us mean a site capable of producing from 90 to 130 cubic feet of white pine per acre per annum.

The premise taken in the opening paragraph is fundamental. To deny its truth is equivalent to denying that the primary aim of forestry is timber production and the maximum of timber production. It would be equivalent to saying that the value of land for purposes of forestry is not determined by the productiveness of the land in terms of timber. It would be equivalent to saying that the relative value of land for forestry and for agriculture is not dependent on its timber-producing capacity, but on its ability to produce *any* agricultural crops.

The forester must decide what land is best adapted to the growing of trees. No one else can decide properly for him, though many will try. He is justified in taking a "show me" attitude with regard to turning over land for agricultural purposes, but how senseless this attitude is if he does not really know the capacity of the land for timber production.

In view of the fundamental character of the statement and its vital importance to every activity in forestry, it has been rather surprising to have this statement questioned by foresters. Perhaps, however, the questions concern the use of terms rather than the fundamental idea. It may, therefore, be desirable to clarify the situation by defining every term.

In using the words "only final" I have in mind "only satisfactory," hence the thing we must ultimately come to, whether we come to it now or get along for half a century with makeshifts. There is, perhaps, a more final and more refined criterion of site quality than mere quantity production. That would be quality production, or the production of the highest grade rather than simply the largest amount. I think, however, we may safely assume that high quality, as regards size and clearness of sticks, will go hand in hand with high quantity production under sane forest management. There is, then, still the question of the density and strength of the material, which may not be at all proportionate to rate of growth. We are still much at sea with regard to the relation of the physical or mechanical quality of the wood to site, but it appears that we may expect to influence this quality also by proper management, and there is little probability that a complete understanding of the subject will disrupt our idea that land is valuable in proportion to its quantitative productivity.

The expression "current annual increment" obviously cannot refer to a single year's growth of the stand, which it would be impossible to measure with sufficient accuracy. "Current periodic annual" would be better, but it makes an attempted concise statement too awkward. The main idea is that the current growth must be measured with reference to the number of living trees in the stand. If we go back too far in this calculation it is impossible to determine how many trees now dead may have made *some* growth during the period of our calculation. If we make the period too short, there is danger of serious error due to high or low rainfall and other factors which vary considerably from year to year. Ten years will ordinarily be the most convenient period for calculation, especially as nearly all stem analyses are made by decades. The growth for a ten-year period can hardly be far enough from the normal, by reason of the climatic element, to count for much.

The cubic-foot increment is taken as the only exact measure of volume increment in English units. Obviously, there are needed for a thousand practical purposes converting factors from cubic to board feet for trees of all sizes, kinds, and conditions and growth. This, however, is no argument for taking such an inexact (and for small sizes, impossible) measure as the board foot for a standard.

A "fully stocked stand" may appear to be a vague thing. The expression is, however, susceptible of exact definition, even if the determination of the condition of stocking is next to impossible. Fortunately, trees are greedy things and quickly appropriate any root space or crown space which is made available to them. Full stocking is, then, delimited by two conditions, namely, spacing so wide that light or moisture or both are going to waste, and, on the other extreme, spacing so close that the trees are kept in a chronically starved condition and hence cannot function properly.

"The species under consideration" is just another way of saying that site quality must be determined in terms of the growth of a given species. In this case, "What is sauce for the goose" may not be "sauce for the gander." We all know that the very best site for western yellow pine may have no value whatever for growing white oak or walnut. Hence the proposal that all sites be classified on the basis of productivity, regardless of species, seems to me very objectionable. Such a proposal, further, assumes that nature or man has already grown on every site the species which will produce the greatest volume growth. This may be true in most cases. But one of the primary objects in site classification is to enable us to compare different species for the same kind of ground and to make certain that the best use is being made of the ground. If one simply described a site as "Quality 111," meaning that it would produce 110 cubic feet of wood per annum, he would be giving the same description to thousands of sites over the country which are in nowise comparable from a technical point of view. Furthermore, the "site quality" must ultimately be reduced to productive and capitalized values in dollars and cents. In this reduction species is a most important element.

In suggesting that foresters in America recognize a standard plan whenever there is occasion to speak of the quality of site, I wish to propose a rather revolutionary one. The primary idea is to have the same numerical terms mean the same thing where used with different species. To accomplish this it is necessary to reverse the ancient custom and give to the *poorest* sites the lowest numbers. Thus any site capable of producing 10-40 cubic feet per annum, of *any given* species, would be Site Quality I (or 1) for that species; 40-70 cubic feet per acre, Site II; 70-100, Site III; . . . 190-220 cubic feet per acre would be Site VII (or 7). Thus, a high number would indicate a high yield or increment, which would be only occasionally met with, while ordinary forest lands would fall between Sites I and III.

A range of 30 cubic feet within each grade is suggested because for local description more minute subdivision may often be desirable, and there is a natural tendency to divide data into either two or three groups. Thus I*a* represents 10-20 cubic feet per acre; I*b*, 20-30; I*c*, 30-40.

As distinguishing this "American plan" from the European usage, it might be desirable to use Arabic rather than Roman numerals.

The following table for lodgepole pine is not ample enough to show exactly within what ranges of stocking the "normal" current increment is obtainable, but does show that probably between the limits of 2,500 and 700 trees per acre, at the age of 55 years, the increment would be essentially the same for all stands. These data were collected with the primary object of determining the optimum stocking, and were all obtained from small plots covering a range of not over one-fourth mile and occupying different parts of a bench which showed no discernible differences in site quality.

Plot No.	Number of trees per acre.	Current annual increment, cubic feet per acre (last ten years).	Present yield, cubic feet.	Total basal area per acre, square feet.	Average diameter of trees.	Average height of trees
4	8,902	49.5	1,671	154.0	1.78	20.4
5	5,242	47.4	1,725	150.0	2.29	23.0
6	3,330	66.9	2,490	166.8	3.03	29.0
10	2,763	No sample trees	....	155.6	3.21	....
7	941	81.7	2,290	112.6	4.68	40.0
8	516	62.7	1,683	94.3	5.79	39.7
9	305	56.5	1,484	82.5	7.07	41.1

Similarly, the writer found, in obtaining measurements on hickory in 1907, that when small plots were chosen whose area was fully occupied, the increment was essentially the same over wide areas of uniform delta land, regardless of the age of the stand. These measurements covered the range between 20 and over 200 years.

It is not the purpose of this paper to analyze or criticise other bases for site determination which have been proposed. It is worth while noting, however, and is beautifully exemplified in the table presented, that those who advocate height on age or ultimate height as the criterion of site are up against exactly the same difficulty in the matter of the influence of stocking as is experienced in attempting to determine the normal increment; and what is worse, under optimum moisture conditions "crowding stimulates height growth" according to the old proverb, while it is plain from the table that under other conditions crowding retards height growth.

And here I wish to bring forth an idea which is somewhat relevant to this discussion and which, I think, is worthy of some consideration. Height is solely controlled by the moisture of the soil. Height cannot, therefore, be an index to the productive capacity of the site, the latter being quite as much dependent on insolation and heat of other sources. Both heat and moisture are necessary to produce starch and, ultimately, wood.

Pearson has recently informally announced the discovery in Arizona that the annual height accretion is controlled by the precipitation during the short period of early summer when height growth is made. But the control of height by moisture goes much further than this. It goes to the point of ultimate height. Just as a thoroughly efficient vacuum pump will lift water only about 30 feet and mercury only about 30 inches, so a tree having a given osmotic pressure may lift water of a given density (of salts in solution) only so far. Thus the height of the tree is limited on the one hand by the density of the soil solution, which is, of course, least when the moisture is greatest; on the other hand, by the density and osmotic pressure of the solution in the uppermost extremity of the tree, which in turn is limited by hygroscopic qualities of the specific protoplasm. It is a pure question of physics that there must be a definite gradient in sap density from the root hairs to the top of the tree, to maintain osmotic transfer of water at a definite rate. Height growth, then, ceases when the minimum gradient commensurate with the demands of the tree and the maximum density which can be tolerated by the protoplasm of the topmost cells have been reached. When the tree can no longer grow upward, it "flattens out," as we say. Every one knows that beyond this stage it may still be capable of its best volume increment.

A young tree grows rapidly because the density gradient may be very high. Similarly, a crowded tree grows rapidly upward because it has a minimum of lateral branches to supply with water, and the existing gradient is, therefore, more than adequate to maintain the necessary supply to the tip. A tree which has overtopped its fellows and has actually outgrown its site is likely to become spike-topped during a series of unfavorable years. In other words, it must "grow back" to a height commensurate with the moisture of the site.

Are not all of these height relations purely moisture relations? Is not height simply an index to the density of the soil solution? To me this seems to be the case, and hence I argue that while height is a criterion of one of the most important qualities of the site, it does not sum up all the qualities which the forester must be interested in and which he attempts to express in the term "Site Quality."

ASPEN REPRODUCTION IN RELATION TO MANAGEMENT

By Frederick S. Baker

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One of the most important trees in the Great Basin of the western United States is the aspen (*Populus tremuloides*), which covers great areas in that region with pure or nearly pure stands. Its value has been comparatively low and the demand small in comparison with the conifers with which it associates. Nevertheless, on account of the ease with which it propagates itself, its rapidity of growth, and simplicity of management, together with its probable future value, some question has arisen as to whether aspen or conifers are to be favored in future forest management, particularly in many parts of Utah.

One of the phases of this problem concerns the matter of reproduction, for the certainty and rapidity with which a stand may be regenerated is a vital point in determining its value under management. It has therefore been one of the objects of the aspen investigations carried on at the Utah Forest Experiment Station in Central Utah to determine the characteristics both of seed and of vegetative reproduction Owing to the importance of the latter, cuttings have been made at three different seasons—spring, summer, and fall—to determine the effect of season of cutting, and in even-aged stands 70, 90, and 110 years old to determine the effect of age upon the resultant sprout reproduction under clear cutting methods. In connection with thinning and permanent sample plots the reproduction in virgin and lightly cut areas has also been investigated.

The most striking fact brought out so far is the weakness of the seed reproduction of the tree in contrast to its great sprouting vigor. This fact has been known for some time in a general way both in the West and East. Pearson[1] states that aspens originating from seed are of rare occurrence in Arizona and New Mexico, but that seed reproduction must take place under favorable circumstances, as its occupation of great burns can hardly be otherwise accounted for. In the East, its great ability to reseed burns is well known; but even here, under

[1] Pearson, G. A. "The Rôle of Aspen in the Reforestation of Mountain Burns in Arizona." Plant World, 17: 249-260, 1914.

favorable conditions, it has been shown that the reproduction must be attributed to root suckers to a much greater extent than has been customary.[2]

Early in the work of the Experiment Station upon aspen it was recognized that aspen seedlings were very rare indeed, and during the six years covered by this study several hundred young aspen trees have been uprooted wherever they have been found in recent burns, isolated situations, and whenever any peculiarity in appearance might indicate that the tree was possibly a seedling. However, not a single seedling has ever been found. It is also usually possible to tell whether saplings up to about three inches d. b. h. are sprouts by shaking them first in one direction and then in another. It will be found that they move very easily in one direction, but are stiff in a direction at right angles to this, on account of the single, straight, shallow, horizontal root from which the tree came as a sucker. The motion which tends to twist this root is much easier than the one at right angles to it. Saplings showing this peculiarity are clearly sprouts. Many saplings which do not show this have been investigated and have been invariably found to be sprouts which have arisen from such large roots or so near stumps that they are relatively immovable in any direction.

REPRODUCTION BY SEED

Pistillate Flowers

A study of aspen seed was made to discover, if possible, the reason for a lack of seedlings. In 1913, 1914, and 1915 no seed at all could be found; in fact, no pistillate catkins were seen, although staminate flowers were found abundantly in scattered localized areas. In 1916 a little "cotton" was found blowing from some unknown source, but careful examination revealed the fact that there was no seed attached to the pappus. In the spring of 1917 it happened that a number of trees were found fruiting. These trees formed a fringe along the lower edge of the aspen belt where it adjoins the mixed oak and sagebrush. Only these marginal trees for a distance of about a hundred yards were fruiting, nearly every tree being free of side shade on one side. The trees in the interior of the stand bore staminate catkins, as they had done the two years previously, and those adjoining on the ends of the fruiting strip were either sterile or staminate. At the time of discovery the seed capsules were about half grown and appeared normal in every

[2] Weigle, W. G., and Frothingham, E. H. "The Aspens: Their Growth and Management." U. S. Forest Service Bull. 93: 19, 1911.

way. A microscopic examination of their contents showed that the great mass of capsules were sterile, containing nothing but pappus. A few capsules, however, which were invariably distinguished in external appearance by having a crooked top or beak instead of a straight, sharp point, were found to contain a single seed which appeared to be normal. As these seed-bearing capsules occurred on an average only once in every 500 capsules examined, the amount of seed produced is infinitesimal.

The development of the fruits was watched continuously on excised branches placed in water in the laboratory of the Experiment Station, as well as by several visits to the trees. Both on the trees and excised branches when the capsules approached maturity the entire spikes of fruit dried up and frequently fell before the capsules opened. In other cases some of the larger capsules opened, but apparently prematurely, as they became dry and hard and infrequently split open sufficiently to free the contents of "cotton." Not over a dozen beaked seed-bearing capsules of normal development and dehiscence were discoevered upon all of the trees.

Under these circumstances it would hardly be expected that reproduction by seed would be abundant, since pistillate trees occupy only a very small portion of the aspen type; only about 0.2 per cent of the capsules on these trees start to set seed and only 5 per cent at most of these succeed in producing and dispersing normal seed. Probably in many years there is even less production than this, and possibly in some there may be greater, although this spring was favorable, being unusually wet and without frost.

Staminate Flowers

The staminate flowers are more abundant than the pistillate, occurring in scattered patches within well defined limits at all elevations in the aspen belt. A typical example of this occurs on the Experiment Station grounds, where there are two stands, one an old 100 to 110-year-old stand, with a partly suppressed understory of about 25-year-old trees coming into the openings below, and an even-aged 40 to 50-year-old stand, with clearly defined limits. Presumably the latter originated after a fire which ran over a portion of the older stand. Nevertheless the old stand and the understory blossom profusely every year with staminate flowers, while the younger stand has been entirely sterile for the last six years at least. Many other stands are known which can be counted upon to bear staminate flowers every year, while adjacent stands are consistently sterile; but the reason for such conditions is not clear.

Staminate trees, while they occupy a wider area than pistillate trees, still fail to cover any considerable percentage of the total aspen-covered area, and it would be quite possible for pistillate trees to exist a mile or more distant from staminate trees, thus making general fertilization very difficult. In the spring of 1917, in a total of approximately 2,500 acres of aspen under observation, only about 20 acres of staminate trees were seen and less than one-half acre of pistillate trees.

The development of pollen was also observed this year, and this has thrown considerable light upon the reason for the general sterility of the fruiting capsules. A careful microscopic examination of thirty-six nearly mature and mature anthers from several trees showed only 44 per cent of the pollen grains normal, round and full of protoplasm, the greater number being small, nearly empty, and frequently wrinkled. Pollen sterility is a condition that is always correlated with hybridism. Five per cent of infertile pollen is considered by Forsaith[3] to be sufficient to indicate this condition. In this case, however, it is impossible to ascribe the condition to this cause, as the species is strictly monotypic and associates in this locality with no other species in the genus *Populus*. In addition to this sterility of the pollen, the staminate flowers, like the developing fruits, appear to start out normally, but just prior to maturity the catkins suddenly dry up and fall from the trees, the anthers withering and failing to open. From only eight out of twenty-five apparently mature staminate aments picked from the trees could visible amounts of pollen be shaken, and this was a very small amount which came from a few anthers near the base of the aments which opened a little, although hardly normally. Nearer the ends of the catkins the anthers had withered without dehiscence. It is little wonder, therefore, that seed reproduction is lacking, since there is so little chance of the seed becoming fertilized, and then the further improbability of the seed reaching successful maturity. It may also be mentioned in passing that the surface soil at the time of seed dispersal is very dry and showers are infrequent, so that germination, except in local wet places, would be extremely unlikely in the short period of viability which these seeds are known to have.

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[3] Forsaith, Carl C. "Pollen Sterility in Relation to the Geographical Distribution of Some Onagraceæ." Botanical Gazette, 62:466-488, 1917.

VEGETATIVE REPRODUCTION

To maintain the density of the stands generation after generation in their wide distribution, it is evident from the preceding discussion that the vegetative reproduction must be of exceptional vigor and persistence.

The investigations under way at the Experiment Station show that while sprouting is more vigorous under some circumstances than others, stands of any age may be clear-cut at any season of the year and still sprout with sufficient vigor to fully regenerate the stand. The vast majority of sprouts come up as suckers from horizontal roots lying near the surface, a much smaller number come from the root collars, and a still smaller number from the stump itself. Rather frequently sprouts are found coming from old groups of sprouts which have originally been root suckers. Prior to the cutting of the parent stand, sprouts arose in these places year after year, existed a season or two, and then died from suppression. Under these conditions a knot of old sprout "stumps" and new buds are finally formed which may attain a diameter of 2 to 3 inches. These always give rise to numerous sprouts when the stand is cut. An examination of 5,417 sprouts on one of the areas which was clear-cut to study the sprout reproduction shows 83 per cent to be root suckers, 9 per cent originating in old sprout groups which are really suckers as well, 7 per cent originating at the root collar, and 1 per cent on the stump itself. On three other plots where old groups were included with those originating directly from the roots, the root-sucker class comprised 89.5 per cent, the root-collar class 10 per cent, and the stump class 0.5 per cent in a total of 1,307 sprouts examined.

Effect of Cutting at Different Seasons

In the case of eastern hardwoods, one of the most important factors which influences regeneration by sprouts is the season of cutting the parent stand.[4] Summer cutting as a rule results in an immediate production of sprouts, which remain tender to the end of the growing season and are killed by the first heavy frosts. Aspen in the intermountain region, however, does not respond immediately after cutting, but delays the maximum sprouting. In the case of fall cuttings the sprouts come up during the year following, as is usual. When cuttings are

[4] Graves, H. S. "Principles of Handling Woodlands." 173. 1911.

made in summer, however, there is no sprouting until the following year, and even when made in the spring, although there is considerable sprouting during the year of cutting, the maximum does not occur until the year following. In all three cases the result is the production of a large number of hardy sprouts. The small number which start late in the season always are frozen back and usually killed by the first frosts in the fall. The maximum density of sprouting is greatest from spring-cut stands, 85,520 sprouts per acre being found upon the spring-cut plot under observation, at the end of the second growing season, while the fall-cut plot showed a maximum of only 41,700 at the end of the first growing season. The summer cutting resulted in about the same amount of sprouting as the fall, with a maximum of 50,960 after one and one-half growing seasons. It is evident that these numbers are amply sufficient to restock the area to full density, as 480 trees per acre is the average in mature stands. The loss from suppression was much the highest on the spring-cut plot; and now, after four years, all three plots are approaching the same number per acre, having between 20,000 and 30,000. Height growth has been little affected by the season of cutting. Sprouts from fall cutting maintained the lead up to the fourth year, when those from the summer-cut stand slightly surpassed them. The sprouts from spring cuttings have grown a little more slowly than those on the other two plots, undoubtedly on account of the extreme density of the reproduction in this case. The average height of all is now between 41 and 46 inches.

Effect of Cutting Stands of Different Ages

The age of the parent stand is another factor which usually affects the amount and vigor of sprouting to a great extent. This was investigated by cutting stands 70, 90, and 110 years old, respectively, as these ages include the sizes of aspen which are now generally utilized. All three stands were cut in the fall of 1914, and in the fall of 1916 showed the following conditions:

Age of stand.	Average d. b. h. parent stand.	Number of groups of sprouts per acre.	Number of sprouts per acre.	Number of sprouts per group.	Average height.
Years	*Inches*				*Inches*
70.............	5.37	27,622	66,772	2.42	19.3
90.............	3.44	40,020	94,622	2.36	15.4
110.............	5.17	12,615	36,540	2.90	19.3

As these three plots were located on very different sites and at different altitudes, the sprouting has been greatly affected by other factors than the age of the stands.

The 70-year-old stand was located on a flat in the middle of the aspen zone where development is most rapid and the stands are at their best. The 90-year-old stand was on a southwest exposure, at nearly the lower altitudinal limits of the species, while the 110-year-old stand was on a southwest exposure above the optimum range of aspen. Moreover, two of the stands were not strictly even-aged, the 90-year and 110-year-old stands having understories of younger trees which reduced the average diameters on these stands very markedly. The only thing of importance brought out in the above table is that the sprout reproduction of aspen is very heavy at all ages at which it is merchantable and on all sites. If the sprouts are cut or are grazed off annually, however, there is no opportunity for the further accumulation of food materials in the roots, and the stores laid up by the parent stand become diminished and finally exhausted, so that sprouting ceases. If the sprouts are destroyed each year for three years, as shown on sprout areas at the Experiment Station which were grazed by sheep, the roots are no longer able to respond and sprouting entirely ceases.

Sprouting in Virgin Stands

When it is considered that any injury to the shallow aspen roots stimulates them into immediate activity, it is rather surprising that there are not more aspen sprouts under the parent stands, especially where grazing is heavy and trampling has injured many roots. Careful examinations beneath representative aspen stands show that there is a continuous and fairly dense reproduction by sprouts every year; but these sprouts are very weak and seldom reach a greater height than a few inches, after which they die of suppression, as they are very intolerant. A few beneath openings in the canopy manage to survive and grow into small, crooked trees. The relation of sprouts to light is shown approximately by the following data gathered from 16 permanent sample plots and thinned areas, in uniform stands averaging from 3 to 7 inches in diameter:

Light intensity (full sunlight, 1.00)	Number of sprouts per acre
.5 to .6	2,784
.4 to .5	2,175
.3 to .4	2,436
.2 to .3	1,255
Less than .2	.....

Since the intensity of cutting, age of stand, and site, as well as light, have also affected the sprouting on these plots, the table is only indicative and pretends to no degree of accuracy. The most striking thing brought out is the lightness of the sprout reproduction in comparison with the clear-cut plots, where 20,000 to 30,000 per acre is about the average.

Effect of Live Stock and Other Influences on Reproduction

While it has been shown that sprouts are produced in much greater numbers following clear cutting than is necessary for the production of a maximum timber stand, provided, of course, that the majority of the sprouts are established, grazing and occasionally rodents may under certain conditions practically eliminate the young sprouts. The handling of live stock in the aspen type on National Forests is a rather general practice, and for this reason the question of the relation of grazing to the establishment of the aspen stand was deemed worthy of careful study.

Effect of Browsing by Cattle and Sheep

Observations extending over a five-year period (1912 to 1916, inclusive) on range in the aspen type used by sheep and cattle separately showed the following results:

(1) Sheep are responsible for severe damage to the reproduction regardless of variety and abundance of forage, and the injury to and mortality of the sprouts was found to be roughly proportional to the closeness to which the lands are grazed. Even where the cropping by sheep was light, the damage was severe.

(2) As a rule, three years of successive moderate grazing by sheep on clear-cut lands resulted in the destruction of the entire sprout stand. Even in the autumn, after the leaves had dropped, sheep devoured a considerable portion of the stems of the season's growth, regardless of the presence of abundant palatable herbaceous forage.

(3) Cattle devoured the leafage and young twigs and branches of aspen reproduction to a slight extent, but the injury was never severe except where the lands were overstocked or where the animals were inclined to congregate and remain for a considerable period. Where cattle grazing was moderate and the stock properly distributed, however, the reproduction was never browsed to the extent of endangering the establishment of a full commercial stand.

Because of the difference in destructiveness to reproduction by cattle and by sheep, the study points to the fact that where considerable areas are to be clear-cut the range may be grazed moderately by cattle during the first three years following the cutting, after which the lands may be utilized by sheep without serious injury to the aspen stand. Three years after cutting, over 90 per cent of the terminal shoots of the sprouts are beyond the reach of sheep, and while the laterals are grazed more or less the subsequent growth and establishment of the sprouts are not seriously impaired.

Destruction of Sprouts by Rodents

A large proportion of the sprouts may be killed or more or less seriously injured by causes other than grazing. Bark-eating mammals—chiefly rabbits, gophers, and field mice,—are responsible for the destruction of as much as 10 per cent of the stand in some instances in a single season. Much of the bark removal is done under the snow and practically all injury of this kind is inflicted during the first five years of growth of the sprouts.

CONCLUSIONS

It is apparent from the foregoing evidence that reproduction by root suckers is practically the only means by which aspen stands are regenerated in this region. As conditions of climate and other factors that would influence reproduction are practically the same now as they have been for the last few centuries, it seems improbable that seed reproduction has been active for a very long time. That vegetative reproduction should still remain so vigorous is remarkable, when the usual rapid deterioration of coppice of other species is considered. It sems improbable, therefore, that any immediate deterioration in vigor of reproduction is to be expected.

This being granted, the management of aspen becomes very simple. Since practically all the reproduction is by sprouts, the silvicultural system is obviously clear-cutting, since this gives rise to the maximum number of sprouts. In uneven-aged stands, where the merchantable trees comprise only a portion of the total stands, every effort should be made to have a cutting of maximum intensity, since the sprouts are very intolerant and tend to form short crooked flat topped trees which will never become valuable under even moderate shade. Unlike the case of most species managed as coppice there is little choice of the season of cutting. This may safely be left to the desires of the operator since sprouting is fully satisfactory at every season of the year. The rotation under which the stands are to be managed may be determined solely upon the basis of the kind of product desired and the age which will yield the greatest income, since, up to 110 years at least the sprouting is entirely satisfactory and ample to restock the cut-over areas to full density. On account of the rapid decadence of the stands at greater ages, rather than any loss of reproductive vigor, it will probably be necessary to use rotations of not over 90 years in the majority of Great Basin aspen stands.

The method of brush disposal in sheep ranges promises to be the most vital point in relation to aspen management, for though the cutting may be made in the most unsystematic way the reproduction is almost sure to be good; yet if sheep are allowed full access to the young aspen sprouts during the first three years they are sure to prevent full regeneration of the stand. As yet the method of brush disposal that will prevent the access of sheep to a suffiicent number of sprouts to reproduce the stand to satisfactory density has not been definitely developed, although administrative experiments are now under way with brush barricades and rough open piling to accomplish this end. Until this is solved, however, sheep must, to assure successful regeneration, be excluded from aspen areas three years after cutting, although moderate cattle grazing is permissible.

It is accordingly evident that from a silvicultural viewpoint aspen is a very desirable species, since its management is simple and reproduction certain, with adequate protection from sheep grazing.

THE EFFECT OF PLANTING METHOD UPON GROWTH OF WESTERN YELLOW PINE

By Harry C. Turner

Forest Planting Assistant, Fort Bayard Nursery

One of the earliest reforestation experiments initiated by the Forest Service, and one which has been conducted in variously modified forms in almost every section of the West where planting has been attempted, is the comparison of different planting methods. In the Southwest, the first few years of practice before intensive experimentation was begun sufficed to show that only the more intensive methods gave promise of success. The three methods most thoroughly tried out in the Southwest are designated and described as follows:

1. *"Side-hole" Method.*—As the name implies, the plant is set with the roots spread against one side of the hole. A hole about 12 inches deep, 8 to 10 inches wide at the top, and narrowed down to about 3 inches at the bottom, is made with a long-bladed mattock. When the soil is rocky, as is usually the case in New Mexico and Arizona, the hole assumes an irregular shape. In the earlier planting, particularly at the Fort Bayard Nursery, an effort was made to cut one of the sides smooth and vertical. The plant was set against this side. In later years the plant was set against one of the rough but usually vertical walls formed by breaking the soil as the mattock is pried out.

2. *"Middle-of-hole" Method.*—In this method the hole is made in the manner described above, excepting that it is usually somewhat wider at the bottom. The plant is set in the middle of the hole. It is held low and in an inclined position, so that the ends of the roots when spread rest upon the bottom of the hole. The roots are quickly covered with loose soil, at the same time raising the plant to the proper height. Since the root ends are anchored by the first application of soil, the laterals tend to remain spread out when the plant is raised, instead of being pressed together, as would be the tendency if the tips were unsupported.

3. *"Mound" or "Cone" Method.*—The hole is wider than in either of the preceding methods, it being usually about 6 inches at the bottom. A small mound or cone is made in the center of the hole by moulding a mass of fresh soil between the hands. The main axis of the root is set

at the apex of the cone, and the laterals spread over the sloping surface extending toward the bottom of the hole. The main advantage claimed for this method is that it insures a natural arrangement of the roots. The greatest disadvantage is the high cost. In rocky soil this method frequently requires a three-man crew—one man with a pick or bar to pry out the rocks, one man with a mattock or shovel to dig the hole, and a planter.

Because of the failures attending the first efforts at planting in this region, the foremost aim of experiments in methods of planting was to ascertain the effect upon survival. After about three years it was found that if reasonable care was exercised in planting, all three methods gave about the same percentage of survival. Averaging results in a large number of experiments, the "mound" method had a slight margin over the other two, but this was more than offset by the increased cost of planting by the "mound" method. As a result, the tentative conclusion was that the "mound" method was not to be recommended for general use. The working plan for these experiments, however, called for annual examinations and survival counts over a period of at least five years.

While making the prescribed examinations on experimental plots at the Fort Bayard Nursery in the fall of 1916, the writer was struck by the apparent superior height growth of yellow pine planted by the "mound" method. The plot in question was established in January, 1912. One hundred 2-1 western yellow pines were planted by the "mound" method and the same number by the "side-hole" method. (The "middle-of-hole" method has not been tested at Fort Bayard.) The planting was so arranged that the two methods were represented by alternating rows of twenty plants each. The site is a level mesa originally occupied by a mixed stand of western yellow pine and alligator juniper which was clean cut years ago, leaving only scattering reproduction. The soil is a clayey loam containing a large admixture of rocks. The striking difference in height growth suggested a measurement of heights, which gave the following results:

The average total height of all trees planted by the "mound" method was 30.9 inches, against 26.2 inches for those planted by the "side-hole" method. The average height growth in 1915 was 8.4 inches for the "mound" planting and 7.2 inches for the "side-hole." In 1916 the respective height growths were 9.5 and 8.3 inches. Eighteen of the "mound" planted trees made an aggregate growth of 24 inches or more for the two years, while only eleven trees planted by the "side-hole" method made an equal growth.

Taking the rows in regular order as they occur in the plot, the average total height for each row appears in the table below. The odd-numbered rows are "mound" planting and the even-numbered rows "side-hole" planting:

TABLE 1

Row No.	Number of trees	Average height	Row No.	Number of trees	Average height
1	15	36.5	6	19	20.6
2	20	30.1	7	17	27.7
3	13	30.4	8	15	24.1
4	11	19.6	9	18	36.5
5	14	22.2	10	17	33.9

It will be observed that in no case is the average height of trees in the even-numbered rows equal to that of the adjacent odd-numbered rows.

A record of annual survivals is given in Table 2.

TABLE 2

Method	Number planted	Number alive		
		Oct., 1912	Nov., 1915	Nov., 1916
"Mound" planting	100	91	77	77
"Side-hole" planting	100	88	82	82

To find out if this difference in rate of growth is in evidence on other sites, a similar planting established in 1913, one year later than the foregoing, was measured in April, 1917, before any new growth had started. This plot is on a steep northwest slope, and the soil is very rocky. The elevation is about the same as the mesa area described above, but is, on the whole, a more typical yellow-pine site, due to the northern aspect. One hundred trees were planted here by each method in alternate rows of 33 to 34 trees each. Only the total height was taken. A good many of these trees have had their growth retarded by tip-moth injury. The average height of the "mound"-planted trees was found to be 16.35 inches, while the "side-hole"-planted trees average only 13.78 inches, a difference of 2.57 inches, or 18.65 per cent, in favor of the "mound" planting. At the same stage of growth the "mound"-planted trees on the mesa were 19.55 per cent taller than the "side-hole," this latter figure being arrived at by subtracting the 1916 growth from the total height.

The average height of trees in each row on the north slope is as follows—odd-numbered rows "mound" planted, even-numbered rows "side-hole" planted:

TABLE 3

Row No.	Number of trees	Average height	Row No.	Number of trees	Average height
1	13	14.0	4	13	13.9
2	24	12.7	5	23	19.0
3	24	15.4	6	13	15.7

Total survivals "mound" planted, 60; total survivals "side-hole" planted, 50.

Again, it is seen that in no case is the average height of trees in the even-numbered rows as great as that of the adjacent odd-numbered rows.

An examination of root systems shows a striking contrast in trees planted by the two methods. In stock planted by the "mound" method the roots grow uniformly in all directions. The roots of stock planted by the "side-hole" method, however, show a marked tendency to grow one-sided, the growth being away from the side of the hole toward the looser soil within.

The effect of layers of compact soil in shaping a root system has been repeatedly demonstrated in nursery work. The root systems of western yellow pine transplanted by the usual "trencher" method invariably develop only in the plane corresponding to the longitudinal axis of the trench. In this method of transplanting, the seedlings are set in narrow trenches formed by forcing a tool, roughly resembling a large spade, excepting that it is wedge-shaped in cross-section, into the soil. Although the soil of a transplant bed is usually in a fine state of cultivation, the walls of the trench become more or less compacted, due to the wedge-like action of the "trencher," together with the sidewise movement usually applied in driving it into the soil.

In both field planting and nursery planting the extension of roots is probably controlled as much by initial direction as by difference in soil texture. In field planting, when a plant is placed against the side of a hole, if the hole is not quite deep enough or if the side is not truly vertical, the tips of the longer roots are turned toward the interior and are apt to continue in this direction. In nursery transplanting the roots, in addition to being confined within the more or less compact walls of the trench, are actually pressed into one plane during the process of filling and compacting the trench.

While it is doubtful whether the advantage in survival and rate of growth indicated would warrant the additional expense involved in "mound"-planting trees, it seems very evident that more care should be taken to spread the roots out as carefully as possible. To that end the holes should be made larger, especially at the bottom. This might be accomplished by equipping the planters with small hand-hoes, by means of which the bottoms of the holes could be cleaned out and enlarged. The roots could then be spread out fairly well and the trees planted in the center of the hole. Although not such an ideal method as "mound" planting, it would be more practical because of the lower cost. It is very evident that any distortion that is imparted to the roots at the time of planting is retained for an indefinite period, possibly for the entire life of the tree; and it is equally evident that this distortion affects adversely the tree's future growth.

FORESTRY AND GAME CONSERVATION

By Aldo Leopold

Secretary, Albuquerque Chamber of Commerce

The technical education of the American forester aims principally to teach him how to raise and use timber. This is obviously proper. Handling timber lands is his major function.

But when the forester begins actual work on a forest he is called upon to solve a much broader problem. He is charged with the duty of putting land to its highest use.

When foresters took charge of the National Forests in 1908 they were not slow to see that they were responsible for the regeneration and development of the Forest ranges. The fact that large areas were overgrazed was considered no reason for letting them remain so. The fact that selfish interests stood in the way of reorganization and progress was considered no obstacle against going ahead. The fact that nobody had ever heard of scientific range management was considered no reason for the continuance of an obsolete system. Foresters undertook to regenerate the ranges on a scientific basis, and succeeded. Today National Forest range management has the opportunity of becoming the most efficient in the world.

When foresters took charge of the National Forests they found their game resources, like their grazing resources, to be in a depleted and non-productive condition. But instead of pushing the work of regenerating the game, they have, by and large, met the situation only as it has pushed them. Today the game resources of the National Forests are, in general, in just as depleted a condition as they were ten years ago, when the Forests were established. Such real work as has been done has been based almost solely on the hand-to-mouth policy of preserving a little sport for the immediate morrow. There has been little vision—little effort to lay broad foundations for an aggressive game policy dovetailing into the policy for the development of timber and range and the recreational needs of the public. In short, the job bears all the earmarks of defensive instead of offensive tactics.

There are, of course, reasons for this anamolous bit of history—reasons no doubt already on the tongues of those who see no cause for dissatisfaction. But it is beginning to be suspected that these reasons will no longer hold water.

First, there is the real and mutual handicap of dual authority over National Forest game. The Federal Government owns the land and has the men on the ground, but the State owns the game and makes the laws. This has resulted in the plan of dual administration under co-operative agreements. It has grown to be almost a habit to consider these agreements fundamentally defective, and in the same breath to assume the absence of any remedy except the complete recession of the one party or the other, in either event raising the dread specter of "States rights." This assumption of three ultimate alternatives, all hopeless, has naturally blasted initiative. But the writer believes the assumption to be incorrect. In the course of a series of future articles, it is hoped to present a new method of co-operative administration, supplemented by some very simple Federal legislation, which will afford a permanently workable plan.

Second, foresters have lacked the stimulus of a strong local demand for better game administration, or, stated negatively, they have to some extent encountered local opposition to any administration at all. They have waited ten years for this demand to grow of its own accord before realizing that it is quite possible to deliberately go out and create it. In New Mexico this has been done, as indeed it was done long ago in connection with grazing administration, where the "will to do" was not lacking.

Third, foresters have labored under the vague fear that a real crop of game might interfere with both grazing and silviculture, as if grazing and silviculture might not also interfere with each other! The principle of "highest use" has evidently been more talked about than understood.

These, then, are the three reasons for the lack of an aggressive game policy on the National Forests. Assuming that they have so far made effective action impossible, they have certainly not made constructive thought impossible. Yet the lack of constructive thought seems, to the writer, to have been the greatest single obstacle to progress in this field. It is significant to recall that such really constructive ideas as that of a correlated system of National Forest Game Refuges were conceived by outside parties. It is the purpose of this paper to urge on foresters their special responsibility and special fitness for supplying constructive thought, and later an actual solution of the game problem on the Forests.

Foresters must consider themselves especially responsible for handling the game problem because: (1) Their work gives them the opportunity to be better acquainted with game conditions than any other class of men. (2) Their training in forestry especially fits them for the work. (3) They are the only large body of scientifically trained men on the ground. (4) If they do not devise means of saving the game, the recreational value of the Forests will be permanently and seriously reduced.

That foresters ought to know game conditions is not open to argument—it is obvious. That a forester's training especially fits him to supply the greatest present needs of the game problem, the writer hopes to establish by showing what those needs are.

In the first place, it is strikingly true that the history of game conservation in the United States has been exactly analogous to the history of forest conservation. Any new movement starts out as a "cause," and the first few years consist mostly of propaganda in furtherance thereof. Forestry started out as a cause, and the first ten years of its history is a story of forestry propaganda. Game conservation has started out as a cause, and as such has about run its allotted course. What, judging from the history of forestry, is the next move?

In answer, it may be well to state that the propaganda stage of forestry was concerned with the question of *whether* our forests should be conserved. The people having answered that question in the affirmative, forestry immediately entered its second stage. In this stage it was concerned with the question of *how* our forests should be conserved. Here the *science* of forestry took the floor, *prepared to cope with the situation.* Foresters had anticipated the need and had developed at least the rudiments of American forest management.

Reverting again to the game question, we may venture the statement that the American people have already answered, in a vigorous affirmative, the question of *whether* our game shall be conserved. Game conservation is ready to enter its second stage, and even the layman is beginning to ask *how* it shall be accomplished. Witness game refuges, game farming, and countless new departures in game laws. The time has come for *science* to take the floor, *prepared to cope with the situation.* But has the need been anticipated, and at least the rudiments of American game management developed. The writer believes it has not.

If it is true that the country is confronted with the eleventh-hour necessity of developing the science of game management, what can the new science borrow from the science of forestry? In the opinion of the writer, a great deal. The following brief analogy, which for the sake of simplicity deals primarily with big game, is self-explanatory:

The first step in undertaking the administration of a tract of game range is to make a game census. This corresponds to timber estimates or reconnaissance. A proper game census should give us the number of head by species (stand estimates), a game distribution map (type map), data by unit areas on predatory animal damage (fire and insect damage), data on water, cover, and foods (soils and site qualities), and figures by unit areas on past annual kill (old cuttings).

The next step is, install a system of patrol against illegal killing and predatory animal damage (timber-trespass and fire damage). This is for the purpose of safeguarding needed breeding stock (growing stock), the loss of which would seriously impair the productiveness of our forest.

We may assume in this analogy that we have an unlimited permanent demand for all the hunting we can furnish (timber market). This being the case, good management *demands* the immediate adoption of a system of regulation of annual kill (annual cut), with the aim of sustained annual kill (sustained annual yield). To determine the amount of breeding stock (growing stock) which is to serve as a basis of sustained yield, we first segregate as game refuges the ranges of rare or threatened species (protection forests). We also segregate as game refuges areas chiefly valuable for recreation and scenery (recreation forests). Next we take the breeding stock on the remaining hunting grounds and determine our annual limitation of kill (limitation of cut).

From here on the analogy is suggestive rather than absolute. For present purposes it will suffice to point out that in the determination of annual kill we use kill factors, which will be explained in future articles. They are calculated empirically and are analogous to yield tables. We may also adopt a killable age of game roughly analogous to a rotation. We also make use of game refuges, bag limits, and a limitation in the number of hunting permits, the combined effect of which is analogous to a combination of area and volume regulation of cut in forestry.

Given a market, we make game laws (sale contracts) specifying certain license fees (stumpage rates). We may adopt limitations on age and sex of animals to be taken, which are analogous to marking rules.

Before cutting begins we decide on the system of regeneration. In most instances this will be natural increase (natural reproduction), but this may be supplemented by artificial restocking (planting). If so, we may establish a game farm (nursery). It is again important to point out that in no case where we cannot restock should we allow even the local removal of more than a fixed minimum of breeding stock (seed trees).

It is the purpose of the foregoing paragraphs to suggest, not to explain, the analogy between game management and forestry. A full explanation must necessarily transcend the scope of this paper. It must be apparent to the reader, however, that the prime necessity for stock-taking, protection against damage, and management for sustained production under a fixed system of regeneration is common to both. Especially so is the principle of guarding at all costs against the depletion of the normal breeding stock (normal stand).

The skeptic may promptly rebut the foregoing analogy. American foresters, he will say, have preached the principles of silviculture, notably sustained yield, but have as yet been unable to practice them. How, then, could they have practiced them with game? True; but why? *Because of lack of a demand* for inferior grades and remote stumpage. Because of our old bugbear—inaccessibility. Does game management labor under the same handicap? Emphatically it does not. *There is a demand for every head of killable big game in the United States,* wherever it may be. Five million sportsmen are looking for hunting grounds, and many in vain. Indeed, it may be said that, as far as a market is concerned, we are more ready to practice game management than to practice forest management.

The next question is: To what extent have the principles of forestry been applied to game?

The big outstanding fact which confronts us here is that absolutely no volume limitation has been applied to the annual kill except bag limits. Having failed to regulate the number of bags, we have really applied no volume limitation at all. There has been applied (but often not enforced) a *time* limitation (hunting seasons), and we have begun to discuss an area limitation (game refuges), but that is all. Hunting seasons and bag limits are essential, but they do not go far enough. They have necessarily failed to prevent depletion of the breeding stock; consequently we are raising little game. What would we expect of a Forest wherein every millman who could pay a license fee were turned loose to cut *ad libitum* from September 15 to November 1, provided he did not haul to market more than 50,000 feet in any one day? Obviously mighty little. Such practice would end by stripping the accessible parts, culling the most desirable species, no matter how badly needed for seed, leaving other areas untouched, and in general creating the antithesis of a productive forest. Yet just so have we created the antithesis of a productive game supply.

Granting that the present system applies no adequate limitation of annual kill, how are we to make good the deficiency? The following is a brief outline of a system of Federal hunting permits which would supply the necessary limitation of kill on the National Forests.

First, take our unit area (in the National Forests this will be a ranger district) and find out what is left in the way of stock. On the basis of game killed (figures, heretofore little used, happily on file for years past), and with due allowance for gradually bringing the stock back to normal, figure out for each species how many animals can be safely removed for next year. Multiply by two for unsuccessful hunters, and advertise the result as the maximum number Federal hunting permits which will be sold for that district for that year, no permit to be sold except on presentation of a proper State license. Sale will take place at a specified time and place, first come first served. Each permit will bear tags, which must be attached to carcasses during possession and later mailed to the Forest officer for cancellation. Possession of carcass without tag, or failure to turn in tags, will be grounds for refusal of permit during ensuing years. The canceled tags and a recensus will form the basis for next year's limitation. The local game protective association (an adjunct to our administration just as necessary as the stockmen's advisory board) should help determine the number and allotment of permits.

The foregoing paragraph is only a suggestive sketch of a system which will be developed in detail in a separate article. The legal basis for putting it into effect would consist of a simple Federal law authorizing the issuance of hunting permits. (Authority to issue such permits, by the way, is already vested in the United States, but it would require an act of Congress instructing the Secretary of Agriculture to exercise it.) It will be seen that no right, title, or interest of the State is in any way interfered with. The whole process consists in "raising the price" on big game, and thus creating a Federal fund to assist the State in its protection. A revision of the co-operative agreement with the State game department would complete the necessary machinery.

It should be noted that the proposed system of Federal hunting permits leaves the fixing of open and closed seasons to the State, as heretofore. The lack of Federal authority in the fixing of seasons has been one of the stock arguments against the present co-operative plan of administration. But with Federal volumetric control of kill, who cares what the open season is, as long as it be within reason? With the annual kill under regulation, open seasons are no longer a vital factor. The necessity for long closed seasons is done away with. The whole question of seasons becomes a mere matter of expediency and convenience.

We started out to prove that the undeveloped science of game management can borrow its framework from the developed science of forestry. It is hoped that the analogy between the two sciences and the sample system in which the analogy is concretely applied will throw some light on the writer's contention that foresters can meet the big needs of the game problem by simply applying the principles with which they, and they only, are familiar.

In view of the impending extermination of certain valuable game species, it seems advisable, before concluding this paper, to make a further comparison between forestry and game management in the matter of selection of species. In the writer's opinion, this is a point which cannot receive too much emphasis.

Forestry may prescribe for a certain area either a mixed stand or a pure one. But game management should always prescribe a mixed stand—that is, the perpetuation of every indigenous species. Variety in game is quite as valuable as quantity. In the Southwest, for instance, we want not only to raise a maximum number of mule deer and turkey, but we must also at least perpetuate the Mexican mountain-sheep, big-horn, antelope, white-tail deer, Sonora deer, elk, and javelina. The attractiveness, and hence the value of our Forests as hunting grounds, is easily doubled by retaining our extraordinary variety of native big game. This variety also adds enormously to their attractiveness for the summer camper, the cottager, and the fisherman. The perpetuation of interesting species is good business, and their extermination, in the mind of the conservationists, would be a sin against future generations.

Forestry does not face so acute a problem. Black walnut or yellow poplar may have become commercially defunct in our hardwood forests, but they are not extinct and never will be. We may destroy them with fire and axe, and burn off the soil of their native habitat to the uttermost extremity of abuse, but some day, somehow, we can always have a walnut or a poplar forest if the demand is sufficiently urgent. But not so with most game. White-tail deer and rabbits seem to have an immunity to extinction, but the great majority of big-game species may quite conceivably become extinct. One species of big game is extinct, two species have already been exterminated from the Southwest, and five more are even now threatened with extermination.

Foresters are quite properly concerned over the threatened commercial extermination of chestnut by blight and white pine by the blister rust. But how much concern is felt over the impending extermination of mountain-sheep and antelope on the National Forests? I am afraid, very little. Yet a good stock of mountain-sheep alone would add millions of dollars to the capital value of National Forest resources. Men go to Tibet to hunt the argali. Surely they would come to New Mexico to hunt *Ovis mexicanus*—if we had any left to hunt.

In conclusion, the writer is sensible of the fact that in arraigning the profession of forestry for a passive attitude toward the game problem, he speaks from the standpoint of a game conservation enthusiast. But why, indeed, should not more foresters likewise be enthusiasts on this question? They should—in fact, they must be, if they are to act as leaders in launching the new science of game management. Enthusiasm for forest conservation was a conspicuous attribute of foresters until long after the propaganda stage of forestry—and a very necessary one. Without it the tremendous first obstacles to launching the new science of forestry would not have been overcome. Without it we shall not overcome the first obstacles to making American game a major forest product.

RELATIVE FROST RESISTANCE OF EUCALYPTUS IN SOUTHERN CALIFORNIA

By E. N. Munns

Forest Examiner, U. S. Forest Service

While eucalyptus in California are in general sensitive to low temperatures, widely divergent claims have been advanced regarding the relative frost resistance of the various species based on their behavior in different localities at different times. The observations during an exceptional period of low temperature recorded in this report furnish important evidence regarding the frost resistance of the various species.

THE COLD PERIOD

Between January 3 and January 8, 1913, southern California passed through a period of low temperature spoken of locally as the "freeze." The first and second days of January were clear and unusually warm. Temperatures throughout the region ranged between 70 and 90 degrees. The morning of the third the wind changed from the southwest to north. A light, three-miles-an-hour breeze was blowing at 9 o'clock. From this time on up to the middle of the afternoon the wind increased in velocity until a speed of 35 to 50 miles an hour was reached.

Like the preceding day, January 4 was clear, but the temperature did not increase perceptibly throughout the day. The next day the wind again increased in violence and power. Trees were uprooted in exposed situations. During this day the temperature remained about the same, with a drop toward evening. In places in the orchards ice formed within a foot of the burning oil in smudge pots.

In 1900 and again in 1911 low temperatures prevailed in this region, but in these years the cold was not as severe as during the winter of 1913. In the interval between December 29, 1900, and January 4, 1901, the temperature did not get below 18 degrees anywhere in the San Bernardino Valley, and during the Christmas season of 1911, 19 degrees was the lowest temperature recorded. Weather Bureau records in this portion of the State do not show another such low temperature period since instruments have been installed in the region, nor can the oldest inhabitant recall its equal. The north winds swept down upon the valley through the passes in the mountains and made useless all the devices used to raise temperature in the citrus groves. Near Pomona orange trees were constantly sprayed with water, and ice formed as it fell. Ice 3 inches deep formed in a watering trough north of the city of San Bernardino, where in 30 years there had never been more than a thin film of ice which melted during the day.

TEMPERATURES

Low temperatures in different localities within the affected area varied somewhat, as is indicated in the following table. The figures given are taken in part from the Monthly Weather Review and in part from apparently reliable observations by private individuals. Considerable discrepancy sometimes occurred in the records from the two sources, due probably for the most part to differences of exposure and to lack of thermometer shelters in the observations not taken by the Weather Bureau. In each case that figure has been selected which appears to indicate at all accurately the lowest temperature to which the trees were actually exposed.

TABLE I

Location	Day of month, January, 1913				
	4	5	6	7	8
	Minimum temperatures, degrees Fahrenheit				
San Bernardino	22	26	18	18*	19*
Redlands	24	22	18	18*	24*
Riverside	21	18	18	19	22*
Del Rosa	24	26	17	14	21
Colton	28	22	18	19*	27*
Highland	..	22	16	16	23
Etiwanda	..	20	19	17	..
Rialto	30	26	23	24	..
Beaumont	29*	20*	16*	24*	32*
Banning	24	21	16	12(?)	..
Ontario	..	26	25	20	27
Pomona	28	25*	20	18*	22*
Monrovia	26	28*	23	18*	19*
Covina	22	23	22	21	24
Santa Ana	24	25	24	24	..
Los Angeles	32	31	26	18	36*
Pasadena	29	31*	25*	21*	25*

* These figures are based on Weather Bureau records.

The following minimum temperatures during the January, 1913, cold spell were given by persons living at or near the places mentioned, but the reliability of the record cannot be vouched for because of the poor grade of thermometers in general use. The figures in the temperature columns indicate the number of times that the temperature at the top was noted in the locality:

TABLE 2

Location	Temperatures, degrees Fahrenheit												
	11	12	13	14	15	16	17	18	19	20	21	22	Total
San Bernardino	..	..	1	2	4	2	5	3	1	1	..	..	19
Redlands	..	..	1	1	3	2	..	3	..	1	..	..	11
Patton	1	1	..	2	..	..	1	..	..	..	..	..	5
Arrowhead	..	..	..	1	1	1	..	..	..	..	..	..	3
Valencia	..	..	..	1	..	1	..	..	..	..	..	..	2
Highland	..	2	1	..	6	1	1	..	..	..	..	..	11
Rialto	..	..	..	2	1	..	1	..	4	1	2	..	11
Del Rosa	1	3	2	3	1	2	1	1	..	..	..	..	14
Colton	..	..	..	1	..	3	2	4	..	1	..	..	11
Bryn Maur	..	..	1	..	2	..	1	..	..	..	..	..	4
Victoria	..	..	..	..	1	1	..	1	..	..	..	..	3
Loma Linda	..	..	..	..	1	..	1	..	..	..	..	..	2
Tippecanoe	..	..	..	..	..	1	..	3	..	1	..	..	5
Mentone	..	1	1	1	2	..	..	1	1	..	1	1	9
Crafton	..	1	..	2	..	1	..	..	1	1	..	..	6
Totals	2	8	7	16	22	15	13	16	7	6	3	1	116

An average of these readings indicates a temperature of about 15 degrees above zero F. in the general locality covered.

EFFECT OF FREEZE IN DIFFERENT SPECIES OF EUCALYPTUS

The effect of the freeze upon the eucalyptus was as noticeable for the most part as upon the citrus trees. The gums and pepper trees looked like oak or beech trees in late fall. Many persons thought the trees dead because they found no moisture in the bark and the leaves were dry and brown. On this evidence a number of groves were cut down. At the present time, however, the citrus, gum, and pepper trees alike have leafed out, and many show no sign other than dead branchwood of the exceptional cold they underwent.

Table 3 summarizes the effect of the low temperatures on the different species of eucalyptus of various ages in the San Bernardino Valley.

BEHAVIOR OF DIFFERENT SPECIES

Eucalyptus globulus Lab. *Blue Gum*

Blue gum has been more widely planted, both for shade and ornamental purposes and for timber and windbreaks, than any other species of eucalyptus grown in the United States. In the nursery blue gum is very sensitive, but becomes hardy with age, though it never attains the degree of frost resistance that *E. viminalis* does. Planted over a wide territory, it caught the lowest temperatures, but not a single tree was found to have been killed by the frost.

The damage to blue gum seldom extended beyond killing of the leaves. In the case of the coppiced tree the one-year-old sprouts were killed, though the stump was still alive, as evidenced by the new adventitious shoots. Only one of the coppice shoots was putting forth new growth, which was the case with several trees where the coppice was but one year old. Coppice two years old and older was not killed, though new growth had to be continued by adventitious shoots.

Dense plantations of blue gum suffered less than more open stands. The leaves on some trees were killed, but in most cases only a fringe of dead tissue was found around the leaf.

Dense plantations of blue gum suffered less than more open stands. The leaves on some trees were killed, but in most cases only a fringe of dead tissue was found around the leaf.

Many people, thinking blue-gum trees dead as a result of the freeze, either pollarded them or cut them down entirely. Trees cut to the ground did not send up very vigorous growth.

TABLE 3.—*Effect of Frost on Eucalyptus*

Species.	Age.	Origin.	Lowest temperature recorded, degrees.	Effect on trees expressed in percentage.								Manner of recovery from frost expressed in percentage.						Basis, trees.
				Entire tree killed.	Tree killed to ground.	Some of branches killed.	Twigs killed.	Leaves all frosted.	Leaves partly frosted.	Part of leaves frosted.	Tree uninjured.	Normal growth.	Adventitious shoots.	Sprouts from root collar.	Sprout from roots.	Sprout on stem.	Sprouts in crown.	
E. amygdalina.....	20*	Seed.....	18	..	..	25	50	25	..	..	..	75	10	..	..	10	5	41
E. amygdalina.....	3	Seed.....	14	..	..	22	55	..	11	12	..	66	12	..	..	11	11	9
E. bicolor..........	3	Seed.....	14	..	..	..	..	..	..	..	100	100	..	..	..	..	..	9
E. calophylla......	3	Seed.....	14	14	86	..	..	..	..	..	..	..	..	..	100	..	..	7
E. citriodora......	18*	Seed.....	18	..	..	55	35	10	..	..	..	30	40	..	..	25	5	9
E. coriacea........	3	Seed.....	14	..	..	..	..	..	12	48	40	95	..	3	..	..	2	60
E. cornuta.........	3	Seed.....	14	..	100	..	..	..	..	..	..	..	10	85	..	5	..	9
E. corymbosa.....	3	Seed.....	14	50	50	..	..	..	..	..	..	..	..	100	..	..	..	4
E. corynocalyx....	18	Seed.....	19	..	..	20	50	12	10	8	..	80	12	..	..	4	4	1,600
E. corynocalyx....	10*	Seed.....	18	..	..	60	20	10	10	..	..	..	50	20	..	20	10	1,000‡
E. corynocalyx....	3	Seed.....	14	8	16	8	16	8	20	24	..	8	24	..	..	50	18	12
E. crebra.........	15*	Seed.....	16	..	..	..	..	..	3	..	97	100	..	..	..	..	..	34
E. crebra.........	3	Seed.....	14	..	..	..	..	..	11	..	89	100	..	..	..	..	..	9
E. crebra.........	5	Coppice..	18	..	..	..	..	..	5	15	80	80	15	..	..	..	5	3
E. diversicolor....	3	Seed.....	14	5	95	..	..	..	..	..	..	..	25	60	..	15	..	250
E. globulus.......	25*	Seed.....	16	..	..	10	15	30	15	30	..	80	10	..	..	5	5	1,500‡
E. globulus.......	13	Seed.....	18	..	..	10	20	10	50	10	..	85	5	..	..	5	5	1,000‡
E. globulus.......	3	Seed.....	14	..	..	..	15	..	60	25	..	80	5	..	..	10	5	420
E. globulus.......	3	Coppice...	18	..	..	10	35	30	20	5	..	..	25	..	..	70	5	12
E. globulus........	1	Coppice...	18	50	50†	..	..	..	..	..	..	..	40	..	60	..	..	6
E. goniocalyx.....	3	Seed.....	14	..	..	..	..	..	80	20	..	70	15	3	2	5	5	292
E. gunii...........	3	Seed.....	14	..	..	..	..	..	5	..	25	100	..	..	..	..	..	8
E. leucoxylon.....	3	Seed.....	14	..	..	..	..	..	..	36	64	100	..	..	..	..	..	5
E. longifolia......	3	Seed.....	14	..	..	..	..	..	85	15	..	50	24	6	..	20	..	9

E. polyanthema...	16	Seed.....	18	..	..	..	5	10	35	50	..	85	5	..	..	5	5	1,000‡
E. polyanthema...	12	Seed.....	20	..	..	..	..	..	70	30	..	100	..	..	..	..	..	75
E. polyanthema....	8*	Seed.....	16	..	..	5	..	..	80	15	..	100	..	..	..	..	..	100
E. polyanthema...	3	Seed.....	14	..	..	..	17	8	23	52	..	90	2	..	..	6	2	7
E. polyanthema...	2	Coppice..	18	..	..	..	10	15	55	20	..	80	5	10	..	5	..	11
E. regnans........	3	Seed.....	14	..	..	..	..	..	..	..	100	100	..	..	..	..	..	9
E. resinifera......	12	Seed.....	18	..	..	..	60	20	10	10	..	70	10	..	..	5	15	103
E. resinifera......	3	Seed.....	14	..	..	..	65	15	15	5	..	80	10	..	..	5	5	9
E. resinifera......	4	Coppice..	16	..	..	5	80	15	..	..	..	80	5	..	..	10	5	6
E. robusta........	20*	Seed.....	18	..	..	10	10	60	..	20	..	80	3	..	..	7	10	13
E. robusta........	12*	Seed.....	16	..	..	10	10	80	..	..	..	77	8	..	..	5	10	27
E. robusta........	3	Seed.....	14	..	..	20	20	50	10	..	..	68	9	..	..	7	16	9
E. robusta........	1	Seed.....	18	..	100	..	..	..	..	..	..	..	5	95	..	..	..	7
E. rostrata........	20	Seed.....	18	..	..	..	15	85	..	..	..	70	5	..	..	15	10	500‡
E. rostrata........	15*	Seed.....	18	..	..	..	5	15	60	20	..	80	10	..	..	..	10	250‡
E. rostrata........	3	Seed.....	14	..	..	..	..	10	80	10	..	70	12	3	3	12	..	2,100
E. rostrata........	1–2	Seed.....	18	..	85	..	..	..	..	..	..	..	6	18	76	..	..	375
E. rostrata.......	1	Coppice...	18	..	100	..	..	..	..	..	..	..	40	60	..	..	..	8
E. rudis..........	3	Seed.....	14	..	..	..	25	70	5	..	..	15	75	5	..	5	..	4
E. saligna........	3	Seed.....	14	..	..	.	..	..	30	5	65	78	11	11	..	..	..	9
E. sideroxylon....	3	Seed.....	14	..	..	..	20	30	40	10	..	10	30	30	..	20	10	9
E. stuartiana......	3	Seed.....	14	..	..	..	5	50	30	15	..	100	..	..	..	..	..	9
E. tereticornis....	20*	Seed.....	16	..	..	..	..	30	60	10	..	76	11	..	..	10	3	24
E. tereticornis.....	12	Seed.....	18	..	..	..	..	20	40	40	..	90	5	..	..	5	..	70
E. tereticornis.....	3	Seed......	14	..	..	30	40	30	..	..	..	70	10	5	..	10	5	1,500
E. tereticornis.....	2	Coppice...	18	..	90†	..	..	..	5	5	..	10	..	90	..	..	..	9
E. viminalis.......	15*	Seed......	18	..	..	..	5	10	20	65	..	100	..	..	..	..	..	1,200‡
E. viminalis.......	3	Seed......	14	..	..	10	5	..	20	65	..	100	..	..	..	..	..	130
E. viminalis.......	3	Coppice...	18	..	..	..	..	..	..	100	..	100	..	..	..	..	..	20

* Age, approximate. † Killed back to stump. ‡ Number, approximate.

To sum up, blue gum, though damaged by frost, recovers rapidly, making new growth from the auxiliary buds and sending out adventitious shoots as well. It should be ranked among the most frost-hardy trees of the genus.

Eucalyptus rostrata Schl. *Red Gum*

Examination of over 200 red gums in the San Bernardino Valley did not disclose a single dead tree, though many at first glance appeared dead. After 12 weeks or so, however, normal growth started, showing that the 18 degrees temperature did not kill the tree, but merely inhibited the growth for the time being.

In several rows of shade trees individual variation in susceptibility to frost was very noticeable. On some trees all the leaves were dry and brown, giving them a dead appearance, while here and there in the row was a red gum free from injury on one side, but with the other side showing evidence of heavy frost. Occasionally a tree would exhibit no damage beyond a few frost-nipped leaves. All the trees in these rows were of the same age and had received the same treatment.

Many trees on which the leaves had been frozen were putting out shoots from various portions of the stem, the bunches appearing at a distance like witches-brooms or mistletoe. Several trees were cut down and these developed vigorous sprouts from the stump. Suckers formed at the base of the trees and less frequently along the trunk.

Bushy trees sent up twice as many sprouts as did the taller, more erect ones, about 60 per cent of the sprouts coming from 2 to 6 inches below the surface of the ground.

In plantations one and two years old 85 per cent of the trees were killed to the ground—a proportion much larger than in the old plantations. Sprouts came from the root collar in all but one instance. Where the trees had been covered with burlap during the cold period, only a few leaves were killed, and in addition to the normal growth sprouts had also developed.

Though in one and two year old plantations the trees evidently cannot withstand temperatures as low as 18 degrees, red gum, like blue gum, on the whole withstands frost well and recovers quickly.

Eucalyptus polyanthema Sch. *Australian Beech*

In its resistance to the cold the Australian beech also resembles blue gum. Not a single tree of the species was found killed to the ground. The most serious damage noticed was in a depression near the Santa Ana wash, where the tallest branch of a tree approximately 8 years old was killed, while the remainder of the tree was practically uninjured. The lowest temperature at the nearest ranch was 17 degrees.

Though many trees examined were almost entirely defoliated by the frost, the great majority lost only about 60 per cent of their leaves. The rest, however, were badly frostbitten about the edges. The twigs and the smaller branches evidently were not killed, as normal growth began eight weeks after the freeze. Adventitious shoots were found on a large number of trees. The majority of these started well out toward the end of the branches rather than on the main stem.

Where the temperature did not fall below 20 degrees, as at Rialto, Ontario, and Mentone, very few of the leaves were frosted and no adventitious sprouts formed, all the growth being normal.

This would tend to show that while the species can withstand temperatures 12 degrees below the freezing point without much damage, temperatures lower than this result in the defoliation of the tree and the development of adventitious buds.

Eucalyptus amygdalina Lab. *Giant Eucalypt*

The giant eucalypt is classed as one of the trees which suffers rather severely from the cold, but which can endure freezing temperatures and yet recover. All the leaves were killed on the trees of the giant gum, and with them some of the larger branches, as well as many of the smaller twigs. Sprouts developed in about nine weeks after the cold, and though the general symmetry of the trees has been spoiled, they are apparently as healthy as before. Its graceful form has brought the species into favor for shade and ornament, and for these purposes the trees have been ruined. Nothing is known of the action of the low temperatures on nursery stock or coppice.

Eucalyptus viminalis Lab. *Manna Gum*

The only damage to manna gum observed was that about 20 per cent of the foliage had been nipped more or less seriously, and that here and there a few twigs were so badly frosted that they did not recover. As with all other species, the younger trees suffered more than the older ones. No sprouts followed the freeze.

The coppice of the manna gum about two years of age was not hurt beyond a few frosted leaves, while coppice a year old was almost defoliated. Young plants set out the winter previous were completely defoliated. The subsequent growth, however, does not show any evidence of injury.

On the whole, manna gum proved to be the most frost-resistant eucalyptus in southern California. For a time it was thought to be the only eucalyptus species which had not been killed, though, as subsequent results have shown, but few others were seriously damaged.

Eucalyptus tereticornis Sm. *Gray Gum*

Large mature trees of gray gum recovered quickly. Most of the new growth was normal, though a number of specimens showed sprouts. A majority of the mature trees were heavily defoliated, but as no wood was killed the trees exhibited no sign of frost injury. In young plantations the effect was different. Wood of last season's growth was partly killed, while the trees were entirely defoliated. New growth started largely from adventitious shoots. These usually occurred in large clusters. They appeared on the stem, as a rule, at least 8 inches above ground, even in one-year-old trees.

Coppice of the gray gum two years old was killed back to the stump, from which new sprouts put forth. Older coppice was not affected as seriously, though the crowns were defoliated. Trees cut after the freeze coppiced freely, both from the stump and from the root collar.

In general, the tree endured the low temperatures without much injury.

Eucalyptus coriacea A. Cunn. *Drooping Gum*

The drooping gum is one of the least known eucalypts in southern California. As far as can be ascertained, the only specimens of this tree are in the Forest Service plantation of 1909, at Del Rosa, near San Bernardino. Here there are about 60 trees, situated in the canyon of the Little Sand Creek. While temperatures about Del Rosa reached the low mark of 14 degrees, residents nearer the foothills reported temperatures of 11 degrees and 12 degrees, and it is certain that this canyon was colder than some of the protected orange groves farther out in the San Bernardino Valley.

In this plantation none of the plants were killed by the severe cold, but the majority of them show slightly injured leaves. On a few trees nearly all the leaves had been killed, though even here there were leaves entirely unaffected by the cold. About 40 per cent of the plantation shows no sign of injury whatever. The regular spring growth was in progress 10 weeks after the freeze. At this time the young leaves were green and the trees were making a fast and vigorous growth. One tree developed adventitious shoots on a small branch and three others sprouted from the root collar. Of 13 species of eucalyptus in this canyon, the drooping gum showed the least sign of injury.

Eucalyptus corynocalyx F. v. M. *Sugar Gum*

The effect of the freeze on the sugar gum varied a great deal with different individuals, even in the same locality and neighborhood.

The following table shows the general effect of the same temperatures in different localities on sugar gum of different age and size:

TABLE 4

District	D. b. h. *Inches*	Height *Feet*	Age	Damage	Temperature *Degrees*
Riverside	24	80	18	Moderate	18
San Bernardino	20	60	14	Moderate	18
Redlands	12	65	11	Serious	18
Colton	8	40	..	Serious	18
Del Rosa	..	6	3	Serious	14

All or nearly all of the leaves of the larger trees were killed and many of the smaller twigs. In two instances, near San Bernardino, the leaves on the north and east side of the trees were killed, while those on the inside of the crowns and the other two sides were only nipped slightly at the edges.

Individual variation in resistance to frost injury was observed in a row of sugar gums in Riverside. Several trees were nearly leafless; some had but few leaves touched by the frost, while still others showed very little damage at all, except for a few injured leaves here and there.

In the Del Rosa arboretum the tips of all the twigs were killed. The topmost branches were killed back for from 6 to 18 inches, and those in the lower part of the crown for from 2 to 6 inches. Ninety per cent of all the foliage was killed, while the remainder was severely injured. On the larger branches new growth occasionally appeared from adventitious buds, but, as a rule, on these younger plants the growth was confined to the main stem within 8 inches of the ground. On some the growth came from 2 to 6 inches *below* ground. Eight per cent of the young trees in the arboretum were killed outright.

Older trees affected by the low temperature produced sprouts, those hurt most usually developing the largest number.

On the whole, this species was rather seriously affected by low temperatures, the older plants being more resistant than younger ones. The non-injury of a number of plants can only be accounted for by individual variation.

Eucalyptus leucoxylon F. v. M. *White Wood*

Like the drooping gum, the white wood has not been planted in southern California except at Del Rosa. Five three-year-old trees are growing in the Forest Service arboretum there, and, judging from these, the tree is not very susceptible to frost, for less than half the leaves show any sign of having been nipped. Normal growth from the axillary buds was in evidence and was concentrated almost entirely on the ends of the topmost branches. In the spring of 1913 the tallest specimen of this species was 11 feet, with a diameter of 2½ inches.

Eucalyptus saligna Sm. *New South Wales Blue Gum*

Nine three-year-old trees of this species are at Del Rosa; the tallest 7 feet. The 14-degree temperature killed about half the leaves on these trees, but new normal growth developed in all instances. One tree put out three sprouts from the root collar and was the only one to give evidence of abnormal growth. The new growth after the freeze (which started early in February) was caught in a frost, when the temperature fell to 28 degrees; but the trees recovered from this within 10 days and new leaves and buds developed.

Eucalyptus resinifera Sm. *Red Mahogany*

In recent plantations, as well as in older ones, not a single tree of this species was found killed to the ground, though 80 per cent or more of the leaves and a large proportion of the small twigs were killed.

Very few adventitious buds developed on the younger trees, and those that did appear occurred within 2 feet of the ground or on the lower branches. Normal growth also took place, however; most of it in the upper part of the crown. This new growth was extremely rapid. Sprouts did not come out in clusters, as in the case of nearly all other species, but were scattered singly or in pairs on the stem.

The older plantations were affected in a similar fashion, but the sprouts came out in clusters rather than singly, high up on the trunk, in the crown, and on the branches. Normal growth was much more rapid than sprout growth. In August the sprouts were apparently dying. Where the temperatures were the least severe, the damage to red mahogany was restricted to the defoliation of approximately half the tree.

Eucalyptus regnans Baker & Smith. *Giant Gum Tree*

Giant gum is probably represented in the San Bernardino Valley only by nine specimens of three-year-old trees at Del Rosa. These trees, the tallest 9 feet and the smallest 4, were unaffected by a temperature of 14 degrees. The examination of these trees in March did not disclose any frost injury whatever, and the seasoned growth, which was taking place almost entirely at the ends of the branches, was being formed at that time. There were no adventitious shoots on the stems or branches and no suckers were coming from the roots. An examination in August showed that in the five months intervening the trees had produced a normal growth of 20 inches.

Eucalyptus citriodora Hooker. *Lemon-scented Gum*

Although the degree of cold that lemon gum can stand without serious damage appears to be limited, no mature trees in southern California have as yet been killed outright. In every case observed the lemon gum was recovering from the damage received. Trees in Redlands were the most severely injured. In one instance the owners, thinking that their trees were dead, proceeded to cut them and dig out the roots, while in an adjacent block the same species was recovering from the freeze. At Smiley Heights the trees seen at a distance, even 10 weeks after the freeze, appeared dead. A closer examination, however, showed that they were putting out new shoots. Some of them were cut back to within about 25 feet of the ground and sent out sprouts along all sides of the trunk from within 4 feet from the ground to within a foot of the cut surface. The largest sprouts were nearest the top. In two cases the sprouts fairly covered the pollarded trunks, while in others they appeared to be making very slow growth.

In every nursery, as far as could be ascertained, the young lemon gums had been killed outright before the lowest temperatures were reached.

Eucalyptus robusta Sm. *Swamp Mahogany*

After the freeze fears were expressed that all swamp mahogany had been killed and the appearance of the region seriously marred. In Redlands a number of trees were cut by owners who thought them dead. After the freeze the leaves all turned brown and fell and many branches were discolored. Two months afterward, however, the trees were all in heavy foliage again and the avenues resumed their former appearance. The sprouts resulting from the freeze were confined almost entirely to the tops. The normal spring growth appeared as usual.

Younger trees in plantations were all defoliated, and the tips of the smaller branches were killed back for from 6 to 12 inches. Sprouts developed in large clusters on the upper part of the stem, but the stronger and more vigorous growth came normally. In several places where young trees had been set out the winter before the plants were killed to the ground, and in these cases sprouts came from the root collar.

Eucalyptus sideroxylon A. Cunn. *Red Ironbark*

The red ironbark has not been planted in the San Bernardino Valley except at Del Rosa. With three-year-old trees the entire crown in a few cases was killed, though, as a rule, the injury to the leaves was not extensive. With trees 5 feet and more in height, many of the smaller branches were killed, especially those in the top of the crown. Normal growth as well as sprout developed; 60 per cent of the latter came from the root collar. Sprouts were well distributed singly on the stem and branches.

Eucalyptus stuartiana F. v. M. *Apple-scented Gum*

Trees of this species were found only at Del Rosa. On the young trees there about half the leaves were killed, while many more had been merely nipped about the edges. On some a few of the smaller twigs were killed, but the spring growth was all normal, no sprouts developing.

Eucalyptus gunnii Hook. *Cider Eucalypt*

The cider eucalypt is represented by 8 three-year-old trees found at Del Rosa, the tallest of which is 9 feet. None of them was injured by the 14-degree temperature of January. Only 5 per cent of the foliage showed the slightest sign of frost damage when examined in March. In the following August one could not tell from their appearance that they had been through a disastrous freeze.

From this it would appear that the tree is well worth further planting in frosty places in California within the range of the genus.

Eucalyptus goniocalyx F. v. M. *Boxwood*

The boxwood is represented by two plantations at Del Rosa. In these plantations not a single tree was found killed to the ground by the cold. The damage appeared to be limited to the leaves. Buds were uninjured, and the normal growth commenced about five weeks after the freeze, when adventitious shoots developed. It would appear that the latter form were stimulated by the cold. The cambium was not injured, although the freeze came at a time when it was beginning to function.

The boxwood produced more sprouts per tree than any other species. Very few of these developed from the root collar or from below the ground, most of them appearing on the stem. From the ground line to the topmost twigs large clusters of sprouts formed (31 sprouts in a single cluster being counted on one tree), and at a distance the plantation looked like a clump of bushes.

Eucalyptus crebra F. v. M. *Narrow-leaved Ironbark*

Narrow-leaved ironbark was found at Banning, Highland, San Bernardino, and Del Rosa, where, as a mature tree, it withstood the lowest temperatures reported. At Del Rosa, in the small sapling stage, it withstood a temperature of 14 degrees above zero F. From the largest tree noted (20 inches diameter and 80 feet tall) down to the smallest three-year-old sapling at Del Rosa (6 feet in height and 1 inch in diameter 6 inches above the ground) the damage was very slight. Only a few leaves were tinged or nipped by the frost. The normal season's growth appeared after the spring rains occurred, and since that time the growth has been steady.

The narrow-leaved ironbark is thus one of the most frost-resistant of the eucalyptus planted in the San Bernardino Valley.

Eucalyptus diversicolor F. v. M. *Karri*

At Del Rosa, where the only karri trees were found, 5 per cent of the three-year-old trees were killed outright by the cold, while the remainder had been killed back to within about 8 inches of the ground. The subsequent growth, however, has been very rapid. Sixty per cent of the sprouts came from the root collar, there being very few sprouts per tree. Reports received from nurserymen showed young stock to be more frost-hardy than that of blue gum. The old trees, however, appeared to be very frost-sensitive.

Eucalyptus cornuta Lab. *Yate*

The only Yate trees found were in the Del Rosa arboretum. Here the three-year-old trees were badly damaged by the low temperature of 14 degrees. All the top part of the plants was killed—leaves, twigs, and stem—to within 14 inches of the ground. Sprouts appeared from adventitious buds 10 weeks after the freeze and grew very slowly. No record was obtained as to frost-hardiness of the species from the nurserymen.

Eucalyptus corymbosa Sm. *Bloodwood*

Bloodwood is represented at Del Rosa by four trees, two of which were killed outright. Roots and stem alike were badly discolored and gave off a very disagreeable odor when cut. The other two trees sent out adventitious shoots from near the ground, but the growth has been very slow.

Eucalyptus longifolia Lind. *Woolly-butt*

The woolly-butt is represented by nine three-year-old trees at Del Rosa. Since the freeze most of these have made very rapid normal growth, though all the leaves were more or less injured. One small, scrubby tree sent up a few sprouts from the root collar, while four others have sprouted along the stems.

Eucalyptus rudis Endl. *Flooded Gum*

The only flooded gum found was at Del Rosa. Here there are four trees, the smallest being 2 feet high. All the leaves were destroyed, and the tips of the branches were killed back for about 6 to 8 inches. The growth since the freeze has been vigorous from both axillary and adventitious buds. One nurseryman reported that this species could be placed but little above the lemon gum as regards frost-resistance.

Eucalyptus bicolor A. Cunn. *Bastard Box*

The bastard box found at Del Rosa was raised from seed sent to this country from South Africa. The temperature of 14 degrees which these trees experienced in the arboretum does not appear to have injured them in any way. New growth started in the latter part of February, and from the general appearance of the trees one could not tell that they had been through a period of low temperature.

One nurseryman reported that the bastard box is a hardy tree in the nursery, although he had not raised any for several years.

Eucalyptus calophylla R. Br. *Feather-veined Gum*

Feather-veined gum is more susceptible to frost than any species of eucalyptus found in southern California. Seven three-year-old trees, grown from Hawaiian seed, were found at Del Rosa. Suckers came from the roots 12 weeks after the freeze, but were puny and weak. Most of them started 6 inches below the ground level. The dead wood was much discolored (black and blue) and emitted a very disagreeable, though rather faint, odor from the cut surface.

EFFECT OF LOW TEMPERATURES ON NURSERY STOCK

The following list of nursery stock is made up from reports furnished by different nurserymen in the region where the study was made. The temperatures to which the stock was subjected ranged from 14 to 24 degrees. The species are arranged in the order of their apparent frost-hardiness, the most resistant first.

Eucalyptus coriacea
Eucalyptus viminalis
Eucalyptus goniocalyx
Eucalyptus bicolor
Eucalyptus regnans
Eucalyptus diversicolor
Eucalyptus hemipholia
Eucalyptus globulus
Eucalyptus sideroxylon
Eucalyptus crebra
Eucalyptus gunii
Eucalyptus rostrata
Eucalyptus polyanthema
Eucalyptus tereticornis
Eucalyptus leucoxylon
Eucalyptus robusta
Eucalyptus corynocalyx
Eucalyptus rudis
Eucalyptus resinifera
Eucalyptus siberiana
Eucalyptus citriodora

The species at the end were for the most part killed outright by the low temperatures. The species first on the list were scarcely nipped by the cold at all, but those in the middle suffered either entire or partial loss of their leaves.

RELATIVE FROST-HARDINESS OF THE DIFFERENT SPECIES OF EUCALYPTS

Very Resistant to Low Temperatures

E. viminalis........................ Manna gum
E. polyanthema.................... Australian beech
E. gunii.............................. Cider eucalypt
E. regnans........................ King eucalypt
E. crebra........................... Narrow-leaved ironbark

Resistant to Low Temperatures

E. tereticornis...................... Gray gum
E. rostrata........................ Red gum
E. globulus........................ Blue gum
E. coriacea......................... Drooping gum
E. resinifera....................... Red mahogany
E. corynocaylx..................... Sugar gum
E. robusta......................... Swamp mahogany
E. gonicalyx....................... Boxwood

Frost Sensitive, but Capable of Recovering from Injury

E. sideroxylon..................... Red ironbark
E. stuartiana....................... Apple-scented gum
E. citriodora....................... Lemon gum
E. longifolia....................... Woolly-butt
E. amygdalina..................... Giant eucalypt
E. saligna.......................... New South Wales blue gum

Very Frost Sensitive

E. rudis............................ Flooded gum
E. corymbosa...................... Blood wood
E. leucoxylon...................... White wood
E. cornuta.......................... Yate
E. diversicolor.................... Karri
E. calophylla...................... Feather-veined gum

CONCLUSIONS

The results of detailed observations of the different species of eucalypts which passed through the freeze of 1913 lead to the following conclusions as to their relative frost hardiness:

1. *Eucalyptus viminalis* is the most frost-hardy species of the genus that has so far been planted in southern California, followed by *E. polyanthema*, *E. gunii*, *E. bicolor*, and *E. regnans*.

2. *Eucalyptus tereticornis*, *E. rostrata*, and *E. globulus* form a second group as regards frost resistance, but because of their usefulness they are particularly deserving of attention from tree planters.

3. *Eucalyptus rudis*, *E. corymbosa*, *E. calophylla*, *E. cornuta*, and *E. leucoxylon* form a third group as regards frost resistance, and should not be planted wherever there is the slightest danger of low temperatures.

4. *Eucalyptus amygdalina* and *E. citriodora* should not be planted for park or ornamental purposes where there is a possibility of heavy frost, because the appearance of these trees is greatly injured by the development of sprouts along the stems and branches after a freeze.

5. Wherever there is any likelihood of very low temperature, *E. crebra*, *E. gunii*, *E. polyanthema*, and *E. regnans* are the best trees to plant for ornamental and park purposes.

6. After a season of low temperature, it is advisable to wait a reasonable length of time before cutting down or pollarding eucalyptus; otherwise trees may be mutilated that would resume their normal appearance in the course of time.

7. When frost is expected, young nursery stock may often be saved by covering the nursery with burlap and by smudging; young plantations may be saved by covering the trees.

INTERCELLULAR CANALS IN DICOTYLEDONOUS WOODS

By Samuel J. Record

There are many representatives of the dicotyledons whose woods contain intercellular canals having contents which are resinous, oily, gummy, mucilaginous, or tanniferous. In some instances—for example, in the Dipterocarpaceæ and certain Cæsalpinioideæ—such canals occur normally and are characteristic of all large stems. In others, ducts arise only in consequence of injury, and thus may be only occasionally observed. In general, dicotyledonous woods containing secretory canals are confined to tropical or subtropical regions.

In some woods the canals are all vertical or axial; in others all horizontal or radial; but in no case has the writer observed them in both planes in the same wood, although a few instances of such have been reported by others. Herein they differ from the conifers, since in the coniferous genera in which resin ducts occur normally (*Pinus, Picea, Pseudotsuga, Larix*) they are invariably disposed in both planes. In consequence of injury, traumatic vertical ducts often originate in the cambium of these four genera, and also in *Sequoia, Abies, Tsuga heterophylla,* and *Cedrus,* which are normally without resin canals in their secondary wood. Such ducts are disposed in tangential series, as in the dicotyledons, and may anastomose more or less. Traumatic radial canals are uncommon in conifers, but have been noted in *Cedrus* and in certain extinct species of *Sequoia,* although always in association with vertical ducts. In dicotyledonous woods, traumatic radial canals may arise independently of the vertical ones, as observed by the writer in a young stem of *Schinus weinmannifolius*, but in other instances—namely, *Styrax benzoin*—both vertical and horizontal ducts may arise as a result of injury. Sometimes the effect of wounding is to produce secretory pockets corresponding to those found in coniferous woods.

Whereas in coniferous woods the normal vertical ducts are dispersed or in tangential groups of 2-3, in dicotyledonous woods the normal vertical canals are usually arranged in tangential series, sometimes producing more or less complete concentric circles on cross-section, giving the effect of growth rings (*Dipterocarpaceæ, Copaifera,* etc.). Again the tangential rows may be very short, or the ducts may be in tangential series in some portions and scattered in others (*Drimycarpus, Daniellia,* etc.). Traumatic canals are disposed tangentially, sometimes in a double row. In all cases where the ducts are close enough together it is usual for them to anastomose into a tangential network which not infrequently excludes everything but the rays, or portions of them, which remain like islands in the tangential section; in *Daniellia* there are, according to Guignard (1), occasional radial anastomoses independent of the rays.

The cells surrounding these vertical canals are mostly parenchymatous, at least at first, though subsequent lysigenous enlargement in some cases may effect a change. The limiting or epithelial cells may be thick or thin-walled throughout or thin only in the part facing the cavity. In the conifers there is always a distinct epithelium, and the cells of it are thin-walled in *Pinus*, but thick-walled in the others, with occasional exceptions. There is no uniformity in the origin and development of dicotyledonous canals, being schizogenous, lysigenous, or schizo-lysigenous, depending upon the species. In the case of *Copaifera*, Rhein found, according to Solereder (2, pp. 285-6), that "side by side with the secretory canals, produced, so to speak, from the cambium, others arise subsequently in the mature tissue of the wood, by the schizogenous origin of a small intercellular space, which subsequently becomes enlarged in a lysigenous manner." In the coniferous woods the resin canals are exclusively schizogenous, and originate only in the cambium. In some instances in dicotyledons (namely, Dipterocarpaceæ) the ducts may become filled with tyloses, corresponding to the proliferation of the thin-walled epithelial cells into the ducts of *Pinus*.

Radial ducts are characteristic of many species of dicotyledonous woods, and vary from extremely minute and only discernible with a compound microscope, to large enough to be seen with the unaided eye. Their location is often disclosed by the discoloration of the wood from their exuding contents, appearing as specks on the tangential section and as lines on the transverse and radial. They are very numerous and show most conspicuously in a wood from British Guiana known as "duka" (*Tapirira* sp.), and are equally numerous, though smaller and less conspicuous, in *Schinus weinmanniifolius*, from Argentina. With a hand lens, and sometimes without it, they are visible in *Astronium* and *Didymopanax*. In quebracho (*Schinopsis*) they are fairly numerous, but owing to the deep color of the wood are usually obscure without a compound microscope. The writer has found the presence of radial canals, as also the vertical ones, very helpful in the identification of tropical woods. Owing to their irregular distribution, they may be present in one section of a wood and not in another from the same specimen.

In different woods with radial canals there is wide variation in the width of the rays. When very narrow, the presence of a duct causes it to enlarge and become fusiform, as in the conifers. In wider rays the ducts, unless very large, may have little or no effect on the shape of the ray. A single ray may contain one or two, occasionally three, and rarely four ducts, and in no case does there appear to be any regularity as to the location within the ray. Usually the cells about a duct are very much smaller than the other ray cells, the greatest disparity being noted in *Rhus laurina,* from southern California, and *R. metopium,* from southern Florida. At the other extreme, in the Araliaceæ examined there is not much contrast in size and shape of the cells, the canals appearing simply as large intercellular spaces among the ordinary ray cells. In the conifers a ray usually contains a single duct, centrally located, but occasionally two are found, especially in *Picea.*

In section, a radial canal is roughly circular or elliptical. The limiting cells are fully as thick-walled as the other cells, and sometimes thicker, though in some instances the wall adjacent to the cavity is thinner than the remainder. In *Odina wodier* (Anacardiaceæ) there is a single distinct and very regularly disposed layer of epithelial cells, with large, simple pits facing the cavity. Viewed longitudinally, each epithelial cell bears a row of these pits which remind one of the pits on the lateral walls of the ray parenchyma cells in *Pinus strobus.* In other cases studied pits into the cavity were not visible, though in most instances the secondary epithelial cells were copiously pitted. Not infrequently these cells are very short, and sometimes very irregular in shape. The canals may be open or more or less completely filled with resinous or gummy material, amber-colored, red, or dark brown. In one case the ducts, though highly resinous, were traversed by mycelium.

Radial canals in the wood are commonly associated with vertical ducts or cavities in the cortex, and (*a*) may end blindly in the ray without reaching the pith (Anacardiaceæ); (*b*) extend to the pith and unite with vertical ducts there (noted in a twig of *Spondias* sp.), or (*c*) connect with vertical ducts in the wood (*Styrax benzoin* and sometimes in *Liquidambar*). Serial tangential sections made by the writer in a twig of *Schinus wienmannifolius* revealed first the few large ducts in the outer cortex, and then the anastomosing character of the numerous smaller ones deeper in. At places in the latter there were branches which turned at right angles and entered the rays. In some rays there was a single duct; in others two or three. Near their end in the wood, which in this instance was in wound parenchyma resembling a pithfleck, they enlarged slightly, and then narrowed to a tiny space between the cells, and next disappeared. This is in substantial agreement with the observations of Trécul (3) on *Rhus viminalis,* the only representative of the Anacardiaceæ in which he noted canals in the rays.

Some woods contain secretory cavities instead of canals, a cavity being an intercellular secretory space spherical or ellipsoidal in shape and having contents which are not mucilagenous. According to Solereder (2, pp. 1100-1), irregular secretory cavities developed by the disorganization of portions of the tissue of the wood have been recorded in *Evodia* and *Xanthoxylum* (Rutaceæ); *Carapa* (Meliaceæ); *Dilodendron* (Sapindaceæ); *Burkea* (Cæsalpineæ); *Terminalia* (Combretaceæ). (See also discussion under "Compositæ.") "With this feature we may associate the formation of tragacanth in the species of *Astralagus* and the occurrence of gummosis in the species of *Acacia* and in the Pruneæ." (Solereder, *loc. cit.*)

Mention may also be made of mucilage canals and cavities. The cavities have been observed, according to Solereder (2, p. 1099), in the wood of *Evodia rutæcarpa* and *Xanthoxylum budrunga* (Rutaceæ), while mucilage canals have been found in the wood of *Herminiera* (Papilionatæ), and sometimes in the wood of certain Sterculiaceæ.

These canals and cavities, which are intercellular, are not to be confused with laticiferous tubes, which are elongated, branching, non-articulated cells with contents of a varied nature, such as latex, resin, etc. While these occur for the most part in the extra-xylem portions of the plant, they may appear as vertical elements in the wood, as in *Carica* (Papayaceæ), or horizontally in the rays where they serve as connections between the tubes of the cortex and those of the pith, as in representatives of the Apocynaceæ, Asclepiadeæ (?), Euphorbiaceæ, Lobeliaceæ, and Moraceæ. The writer has found the presence of these tubes in the wood rays of *Brosimum* (Moraceæ) to be a valuable diagnostic character. Trécul (9) noted connective laticiferous tubes in the rays of certain species of *Euphorbia, Dorstenia, Lobelia, Tupa, Isotoma, Centropogon, Siphocampylus,* and *Beaumontia.*

Following is a brief synopsis of the various families of the dicotyledons in which intercellular canals in the wood have been observed by the writer or reported by others. The lists are as complete as the writer can make them at present, but undoubtedly are capable of considerable extension. The writer is indebted to Prof. I. W. Bailey, of the Bussey Institution, for specimens of several of the species listed.

Hamamelidaceæ

In *Liquidambar orientalis* and *L. styraciflua* there are normally no secretory canals in the wood, though schizogenous canals occur in the pith. As a result of injury, however, vertical canals may arise in the wood of both species and produce a gum known as storax. The writer has observed them in various specimens of our native species (red or sweet gum), where they present the usual tangential seriation and network. A specimen from Honduras shows them very prominently developed.

Tschirch (4, p. 1204 *et seq.*) and Svendsen (5) investigated the canals produced pathologically in these species. In the new wood in a wound in *L. styraciflua* there were three concentric rows of canals embedded in a zone of tracheidal-parenchyma. Their increase in size by the breaking down of the surrounding cells was plainly noticeable, and this process extended to include portions of the rays. No canals in the bark or radial canals in the wood were observed. This is in agreement with the present writer's observations, but contrary to those of Moeller (6, p. 13), who noted secretory cavities in the bark in communication radially with vertical canals in the wood.

Rosaceæ

The presence of canals and cavities in the woods of the Prunoideæ is a matter of common observation. Their formation is ascribed to gummosis or modification of the cell walls, not of normal tissues, as in *Acacia,* but of previously differentiated groups of parenchymatous cells, so-called "abnormal wood parenchyma."

The specimens examined by the writer show vertical canals in tangential series—small, but conspicuous, because of the dark red color of the contents which test for mucilage rather than gum. The surrounding cells of the wood parenchyma and the rays are short, thick-walled, and copiously pitted, as, for example, in *Liquidambar.*

Leguminosæ

Among the papilionaceous woods, gum canals appear in the older xylem of *Herminiera elaphroxylon* (4, pp. 264-5), being placed vertically in the wood and horizontally in the rays.

In the Mimosoideæ, the normal elements of the soft bast, pericycle and wood of *Acacia* may undergo metamorphosis into gum (gum-arabic) (2, p. 297), but no secretory canals in the wood have been recorded.

In the Cæsalpinioideæ, vertical secretory canals have been described by Guignard (1, 7), Mezger (8), Tschirch (4, pp. 770, 1054, *et seq.*), Solereder (2, pp. 905, 1102), and others as characteristic of the secondary wood of *Copaifera, Eperua, Kingiodendron, Prioria, Daniellia,* and *Oxystigma.* The writer has observed them in various species of the first four genera mentioned, and also in *Sindora supa,* and in an unidentified Brazilian wood labeled "bate caixa," and rather closely resembling *Prosopis.* In the various species examined the canals are in concentric lines, more or less continuous, appear as delimiting the growth rings, and exude an oily substance which stains the surface of the wood. They serve as a dependable diagnostic feature, and their presence can be determined with a hand lens and often without it on account of the exudations.

According to Guignard (*loc. cit.*) the canals in *Daniellia thurifera* and *D. oblonga* are very much like those in *Copaifera,* except that in the latter they are arranged in regular circles in the early wood of successive growth rings, whereas in *Daniellia* they are more irregularly disposed and the tangential anastomosing is not so marked. He also reports that radial anastomosing occasionally occurs. In both genera the epithelial cells have larger nuclei than the surrounding cells. The walls next the cavity of the duct are noticeably thinner than in other portions of the cells, but these walls, even in their thickest portions, are never lignified. The epithelial cells are usually short, but in contact with wood fibers they elongate somewhat. Trees belonging to this group are the source of valuable balsam, which is obtained by tapping.

Rutaceæ

Although, as previously stated, secretory cavities have been recorded in *Evodia* and *Xanthoxylum,* Solereder (2, p. 856) states that these are without doubt in the nature of mucilage spaces, and (p. 181) that characteristic secretory cavities are completely absent in the wood. No reference to intercellular canals in the wood has been found.

Two woods from the Canal Zone, namely, *Xanthoxylum elephantiasis* and *X. pittieri,* show numerous small vertical canals in irregularly disposed concentric arcs and semicircles. Here and there in the rows one may find large masses of parenchyma like pith-flecks, with or without intercellular canals. Another specimen from Panama—a soft yellowish wood with reddish-brown streaks and highly tanniferous—contains a few canals. This wood is evidently a species of *Xanthoxylum.* The canals are without epithelium and the irregular disposition of the limiting cells affords evidence of the lysigenous development. The contents test for mucilage. The writer has noted similar canals in *Citrus.*

A hand specimen of *Esenbeckia febrifuga* collected by Huber, of the Museu Goeldi, Brazil, shows small canals in numerous tangential rows—some very short, others continuous across the block. They are presumably of traumatic origin and appear on the longitudinal surface as narrow, inconspicuous lines, darker than the light-colored wood.

Another specimen from the same source and labeled "tamanquiera" contains numerous small canals in tangential series. Although the name "tamanquiera" is applied by Huber to two woods, namely, *Fagara rhoifolia* and *Ocotea guyanensis* (Lauraceæ), the structure corresponds to that of the Rutaceæ. It seems unlikely that canals would be found in the woods of the Lauraceæ, although Höhnel (15, p. 166) reports finding them in the wood rays of *Oreodaphne*. Solereder (2, p. 704), however, says Höhnel's statement "is without doubt incorrect," as is also his report of finding secretory canals in the phloem rays extending to the bark and presumably into the wood rays (although the latter were not investigated) of *Myrica sapida* (Myricaceæ).

Simarubaceæ

Two different specimens of the wood of *Simaruba amara* from Brazil contain numerous small canals closely arranged in tangential series extending throughout the length of the specimens. In one of the pieces there are several rows, some of which are only a few ducts wide. They are filled with amber-colored material which exudes on the white wood, producing distinct lines on the longitudinal surface.

Burseraceæ

According to Tschirch (4, pp. 1202-3) the wood of *Canarium commune* normally contains no secretory canals. In response to severe injury of a stem under observation a tangential row of traumatic ducts was formed in the inner portion of the new wood and embedded in a broad zone of parenchyma, with scarcely any tracheidal-parenchyma present. The ducts originated schizogenously and enlarged lysigenously, showed the usual tangential network, but were not connected with the canals in the cortex. Unless a wound is severe, no ducts in formed in the wood, though resin pockets arise similar to those in coniferous woods.

Meliaceæ

Vertical canals of pathological formation (gummosis ?) have been observed by the writer in various specimens of the wood of *Swietenia* *mahogany* and of *Cedrela* sp. In *Cedrela* they are rather large and conspicuous, arranged in close tangential series with the usual anastomes, and filled with dark-red gum. They are evidently lysigenous—at least in the later stage of their development. In *Swietenia* the ducts are smaller and less conspicuous because of the contents being amber-colored. They are frequently in a double row.

Resin cavities are said to arise in *Carapa guianensis* through disorganization of groups of cells (2, p. 1101; 4, p. 197).

Anacardiaceæ

Trécul (3) found in *Rhus viminalis* that branches of the resin canals in the bast penetrated the medullary rays of the wood, and ended blindly. The present writer has found no other reference to secretory canals in the woods of this family, but has observed vertical canals only in *Drimycarpus racemosa* and radial canals only in the following: *Astronium* sp., *Buchanania latifolia, Garuya abilo, Gluta tavoyana, Koodersiodendron pinnatum, Odina wodier, Rhus laurina, R. metopium, R. rhododanthema, Schinopsis lorentzii, S. balansæ, Schinus wienmannifolius, Spondias mangifera, S. lutea, Tapirira* sp.

Bombaceæ

Vertical traumatic ducts have been noted by the writer in a specimen of wood of *Pachira* sp. from Colombia. In size, appearance, and arrangement these canals closely resemble those in *Cedrela*.

Dipterocarpaceæ

The writer has observed vertical canals in various representatives of this family, but radial canals are apparently absent. Vertical canals are said to be present in all genera except *Lophira, Ancistrocladus,* and *Monetes*. The interxylary resin ducts are mostly surrounded by wood parenchyma, but sometimes by prosenchyma, and they are often arranged in concentric circles. They may not appear until late in the secondary growth of the wood, and may become filled with tyloses. They have been reported upon by various writers, among whom may be mentioned Van Tieghem (10), Guerin (11), and Solereder (2, pp. 139-40; 840-1).

In addition to the vertical ducts normally present, others may be induced to form, as in *Pinus*, by wounding, as demonstrated by Tschirch (4, pp. 1203-4).

Schneider (12, p. 162) says: "The most characteristic feature of the family is the presence of numerous resin ducts, partly scattered, but more often arranged in conspicuous narrow concentric lines, giving the appearance of growth rings. That they are not growth rings is shown by their very irregular spacing, and, what is more conclusive, by the fact that they rarely form complete circles. The presence of distinct resin rings proves that a specimen [of Philippine wood] belongs to this family, but they are so irregularly arranged that a small specimen may often be without them."

The woods commonly known as Philippine mahogany (lauan, tanguile, tanguile mahogany, Bataan mahogany, etc.) belong to this family, and the concentric rings or arcs of small canals with their whitish deposits afford a ready means of separation from other commercial mahoganies, now of special importance for airplane propellers.

Combretaceæ

As previously stated, secretory cavities developed by the disorganization of portions of the tissue of the wood have been reported for *Terminalia.*

In *Terminalia catappa,* from Hawaii, the writer has observed large, well-defined secretory canals arranged in tangential series, and showing the usual anastomosing character in tangential section. The surrounding cells are small and short, rounded on the side next to the cavity, and show no wall fragments such as are seen in the case of *Liquidambar.* They were first noted by Brown (13).

Myrtaceæ

Although secretory cavities occur in the leaf and in the ground tissue of the axis of this family, the writer has been unable to find any reference to secretory canals or cavities in the wood.

In the woods of *Eucalyptus citriodora,* from Hawaii, and *E. pilularia* and *E. maculata,* from Australia, the writer has found well-defined gum canals extending throughout the length of the specimens (maximum about 0.3 meter). They are in a zone of parenchyma in a short tangential series, with their greatest diameter radial, the largest measure 2 mm. across at the widest part. They anastomose very frequently, and are partially filled with gummy substance. They are occasioned by wounding, and while their mode of origin is unknown, they have evidently enlarged lysigenously.

Araliaceæ

Only radial canals have been observed in this family. The writer has observed them in the wood of three representatives, namely, *Cheiro-*

dendron gaudichaudii and *C. platyphyllum*, from Hawaii, and *Didymopanax morototoni*, from the Canal Zone and Argentina. The first two were first noted by Brown (13).

Viguer (14) considered *Arthophyllum diversifolium* unique among the Araliaceæ on account of peculiar cavities noted in the rays which he calls "poches secretrices." The present writer has had no opportunity to examine the wood of this species, but from Viguer's drawing it appears certain that these so-called secretory cavities are ducts such as found in the other species mentioned above. This is also the opinion of Solereder (2, p. 946).

Styraceæ

According to Tschirch (4, p. 1199), vertical canals appear in the wood and bark of *Styrax benzoin* as the result of injury, but do not occur normally. They arise schizogenously in the zone of new wood nearest the old, and are later enlarged lysigenously until a continuous tangential network results about the rays, some of which, in fact, are also partially or entirely broken down.

Canals also develop in the bast and communicate with those in the wood through the rays. These radial canals, which are also schizo-lysigenous, arise in the cambium, where they are very small, and enlarge progressively from it.

Boraginaceæ

The writer found vertical canals, presumably of pathological formation, in certain specimens of *Cordia* sp. from Colombia and Venezuela. In the Venezuelan wood known as "pardillo" the canals are situated in a zone of wound parenchyma, are filled with a clear yellow balsam in which are embedded numerous free parenchyma cells, or small groups of them, which have evidently become detached during the lysigenous enlargement of the ducts. In some places the detachment is not complete. In other places the partial disintegration of the limiting cells is clearly shown.

Compositæ

Vertical secretory canals are reported in the secondary wood and bast in the tubers of *Helianthus tuberosus* and horizontal ducts in the rays of the secondary wood and bast in the fleshy roots of *Dahlia*.

Secretory cavities in place of canals have been reported in the bast and wood in the root and rhizome of *Inula helenium* and in the rays of bast and wood in *Anacyclus pyrethrum* and *Carlina acaulis* (Solereder, 2, pp. 956-7).

SUMMARY

Intercellular canals are shown to occur in the secondary wood of representatives (mostly tropical) of sixteen families of dicotyledons, namely, Hamamelidaceæ, Rosaceæ, Leguminoseæ, Rutaceæ, Simarubaceæ, Burseraceæ, Meliaceæ, Anacardiaceæ, Bombaceæ, Dipterocarpaceæ, Combretaceæ, Myrtaceæ, Araliaceæ, Styraceæ, Boraginaceæ, Compositæ. Many of these have not been previously reported.

In some cases the canals are normal features of the wood; in others they develop pathologically. Woods with normal canals may have others produced as a result of injury.

Canals may be vertical only, radial only, or very rarely in both planes. The radial canals are contained in the medullary rays, and vary in number from one to four.

In origin the canals are schizogenous, lysigenous, or schizo-lysigenous.

The secretory canals in dicotyledonous woods afford numerous parallels to those in gymnosperms, but in many important features are quite distinct.

The secretions in dicotyledonous woods exhibit a wide range of variation, being resinous, oily, gummy, or tanniferous, as opposed to the conifers in which the secretory products of the wood are wholly resinous.

The presence of intercellular canals in a wood serves as a valuable diagnostic feature. It was from this point of view, rather than with reference to the origin of the canals and to the nature of their contents, that this study was made.

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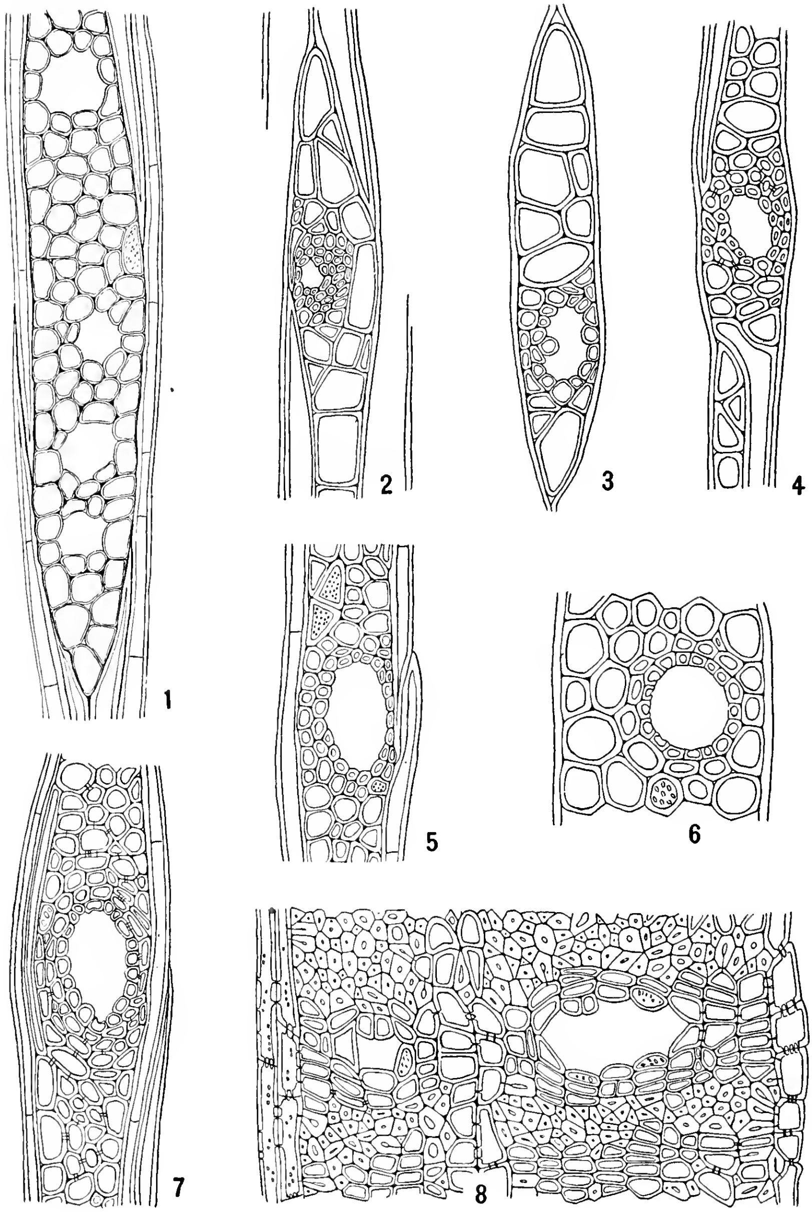
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EXPLANATION OF FIGURES

Fig. 1. Section of a ray of *Didymopanax morototoni* (Aral.) containing four secretory canals. It will be noted that the limiting cells are of approximately the same size and shape of the other ray cells.

Fig. 2. Section of a ray of *Rhus laurina* (Anac.) showing an extremely small intercellular duct surrounded by numerous small cells, which exhibit decided contrast from the others.

Fig. 3. Section of a ray of *Gluta tavoyana* (Anac.) showing a canal near one edge and the small size of the limiting cells.

Fig. 4. Section of a ray of *Astronium* sp. (Anac.) with a duct surrounded by very thick-walled cells.

Fig. 5. Typical canal in the rays of *Santiria nitida* (Burs.).

Fig. 6. Section of a canal in a ray of *Odina wodier* (Anac.) showing a distinct epithelium composed of a single layer of cells with large simple pits facing the cavity.

Fig. 7. Typical radial canal in quebracho, *Schinopsis lorentzii* (Anac.).

Fig. 8. Transverse section of two vertical canals in the wood of *Drimycarpus racemosa* (Anac.). They are in a tangential zone of wood parenchyma and show no evidence of lysigenous enlargement.

CHANGES IN THE FOREST AREA OF NEW ENGLAND IN THREE CENTURIES

By Roland M. Harper

When the Pilgrims landed at Plymouth, in 1620, probably at least nine-tenths of the area now known as New England (not counting the numerous lakes and ponds), as well as of the rest of the country east of the Alleghanies, was covered with forest.[1] The principal treeless areas seem to have been dunes, marshes, intervales, meadows, bogs, mountain summits, and Indian clearings. Just how much land was cultivated by the Indians we have no means of knowing; but the aboriginal population is supposed to have been less than one per square mile, and as they lived mostly by hunting and fishing they did not cultivate much land; and even if we allow one acre per capita, that would be not much more than a thousandth of the total area.

One of the first tasks of the white settlers was to clear away the trees to make room for crops, and as the population was augmented by new arrivals the forest receded, so that even before the end of the seventeenth century a scarcity of timber began to be felt in some of the colonies. The absence of railroads and other easy means of communication with the interior in the first century or two compelled each colony to feed itself almost entirely, instead of importing food from distant parts in exchange for the products of quarry, forest, and factory, as at present. As the soil of New England is not especially noted for fertility, it probably took about five acres of cultivated land and pasture (which is about the average for the whole United States today) to feed each person, except perhaps in the vicinity of the coast, where sea-food was available; and as the artificial manures which are now widely used to maintain soil fertility were then mostly unknown, a little more new land had to be cleared every year to take the place of that exhausted by cultivation, even where the population did not increase.

About the middle of the nineteenth century, however, a new factor

[1] R. S. Kellogg, in Circular 166 of the U. S. Forest Service, on the timber supply of the United States (1909), estimates the original forest area of Massachusetts at 90 per cent and that of each of the other New England states at 95 per cent.

entered into the situation and gave the New England forests a new lease of life. By that time the North Atlantic States were connected with the country west of the Alleghanies, where the land is comparatively level and free from stones and the soil generally very fertile, by the Erie Canal and several lines of railway; and as the means of interstate transportation became more numerous and efficient, it gradually became more economical to raise the staple crops in the Mississippi Valley, instead of on the rocky hillsides of New England, and ship them around and across the mountains in exchange for manufactured articles. New England had been endowed by Nature with abundant water-power, which is lacking in large areas in the interior of the continent,[2] and the development of transportation facilities enabled each section to specialize more and more in the industry for which it was best fitted.

This change of economic conditions caused many of the New England farmers to migrate westward to continue their occupation under more favorable circumstances,[3] while many others, or at least their children, moved to the towns and cities to work in the factories; and while new factories were springing up in southern New England, the forests of Ohio,[4] Indiana, and neighboring States were being cleared away at a fearful rate. The increase in New England population in recent decades, though very large in some of the states (Massachusetts, Rhode Island, and Connecticut having gained nearly 3 per cent a year for the last 60 years), has been almost entirely in the cities and factory towns, and the rural population has declined.[5]

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[2] In 1909 over 40 per cent of the water-power used in manufacturing in the United States was located in New England, and over 25 per cent of the total power used in New England (as compared with less than 7 per cent in the rest of the country) was generated by water. At earlier census periods the relative importance of water-power was still greater, but even now the Merrimac River is believed to be turning more spindles than any other river in the world.

Generally speaking, the richest soils of the United States are in regions with little or no water-power, where the streams are sluggish and muddy, as in Illinois and the great valley of California, or scarce, as in Nevada and the high hammock regions of Florida; and similar correlations seem to hold in some other parts of the world.

[3] In 1870 there were 568,707 natives of New England living in other parts of the United States, and the number has changed little since; so that the total emigration must have been well over a million.

[4] The wooded area of Ohio decreased from over 50 per cent in 1850 to about 20 per cent in 1880, and cannot be over 15 per cent at the present time. The extinction of the passenger pigeon was probably due very largely to the destruction of the hardwood forests of the Mississippi Valley, in which its vast flocks used to rest during their migrations.

[5] The census statistics of rural and urban population are not very satisfactory for New England, where the township is the unit of enumeration, but the statistics of occupation show the same tendency very well. The percentages of the

In New England as a whole, as in some other near-by states, agriculture seems to have reached its maximum extension about 1875. From 1880 to 1910, according to the Government census figures, the acreage of farm land decreased in every state north of North Carolina and east of Kentucky and in parts of several other eastern states; and at the same time the acreage of woodland on farms increased (not only relatively, but absolutely) in nearly every county in New England, and decreased less than the total farm land did (thus making a net gain in total woodland) in New York, New Jersey, and a few other states. The increase of forest area has already been commented on by others, particularly in southern New Hampshire, where it has been most pronounced. As long ago as 1885 the report of the Forestry Commissioners of New Hampshire contained some observations on this point. An unsigned article in the New York *Evening Post* of September 28, 1907, entitled "Man's defeat by Nature: the tragedy of the New Hampshire hills," says in part:

"Human muscle could no longer cultivate the fields. Pines grew up in the pastures and overshadowed the feed of the cattle. Black alders sprouted thickly by the brooks and encroached upon the mowing. Brush filled in the roadsides and miles of little-traveled highway . . . were abandoned. . . . Nature was closing in, year in and year out, by summer increasing the growth of brush and tree, by winter filling the long miles of lonely road with deep drifts of snow."

With the extension of forest area there has been a perceptible increase in numbers of certain wild animals, such as deer. But of course even if farming should cease entirely in New England the forests could not go on increasing indefinitely, for the rapidly growing urban population requires a considerable space for dwellings, stores, factories, parks, golf links, cemeteries, roads, railroads, etc. Some estimates of the area thus occupied will be given farther on.

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total number of workers engaged in agriculture and manufacturing in New England and in the remainder of the country, in 1840 and 1910, are as follows:

Occupations	New England		Rest of United States	
	1840	1910	1840	1910
Agriculture	62.3	10.4	80.0	35.1
Manufacturing	28.1	49.1	14.6	26.2

In the whole United States the ratio of rural to urban population—that is, of persons living in places with less and more than 2,500 inhabitants—is very nearly the same as that of farm to factory workers, and the same would doubtless hold true in New England if the rural and urban portion of each township could be returned separately.

The occupation ratios for New York and New Jersey at both census periods named were not very different from those for New England, doubtless for similar reasons.

Although the change in the amount of woodland in New England has been observed by many, it does not seem to have been shown statistically very well hitherto. The writer has recently extracted from census reports some interesting information on this point, and as the results are obtained in a rather roundabout way, the method will be explained in detail, so that readers may judge for themselves how much confidence can be placed in it and perhaps at the same time think of improvements.

The first census of the United States (which was the first of similar scope in the world) was taken in 1790. A few estimates of the population of the New England colonies had indeed been made before that, but if we disregard them and assume that the population of each increased uniformly from the time of first settlement to 1790, we will probably be near enough to the truth. The first six decennial censuses dealt chiefly with population, but that of 1850 gave the acreage of improved and unimproved land in farms in every state and county, improved land being that cleared and used for grazing, mowing or tillage, or lying fallow, and unimproved being mostly woodlots. Similar data were given in 1860; but in 1870, under the direction of Gen. Francis A. Walker, the noted economist, an improvement was made by separating the woodland from other unimproved land. (In 1880, again under General Walker, the improved land was also divided, into tilled and untilled, which however has little to do with our problem.)

In 1890 and 1900 the farm land was divided into improved and unimproved, as in 1850 and 1860, but the definition of improved land was narrowed to exclude abandoned fields and rocky pastures. Finally, in 1910, the woodland was separated again, as in 1870, and it is to be hoped that this distinction will be maintained in future censuses. In recent decades some of the individual States have taken censuses midway between the Federal ones, giving similar data; but these are comparatively inaccessible and will be ignored for the present, in order not to complicate matters too much.

To get the total forest area of any state (or county) at any census period from these data, we may proceed as follows: First deduct the area assumed to be originally treeless (5 per cent) and that occupied by cities, towns, etc. No statistics of the latter are given in the Government census reports; but if we allow a fifth of an acre per inhabitant we will probably be not far wrong, for although that may be too little for rural communities, where houses have large yards, it is certainly too much for the cities, where the population is more congested. It is better to err on the side of exaggeration, however, to make allowance for treeless areas that have been overlooked, and the total urban area is rather small anyway. (At the time of the last census it apparently amounted to less than 1 per cent in Maine, and scarcely 15 per cent in Massachusetts and Rhode Island.) After these two deductions are made, it is pretty safe to assume that the remainder of the land not in farms is in forest; for in this part of the world all land that was once wooded tends to revert to forest when unoccupied, and although considerable areas of forest may be cut clean by lumbermen from time to time, the trees usually begin to grow again at once, so that it is still forest land.

To the woodland outside of farms must then be added that in farms, which is given directly for 1870, 1880, and 1910. For intermediate census years we may assume without serious error that the ratio of woodland to total unimproved farm land was the same in 1890 as in 1880, and in 1900 as in 1910, or else interpolate a little. The woodland for 1850 and 1860 may be estimated in a similar manner from the 1870 figures.

Back of 1850 we are somewhat at sea, having only the population figures to go by (except that farm products were returned in 1840). But we can now assume that the ratio of farm land to population was the same for several decades previous to 1850 as it was then, unless there was a decided change in the ratio soon after 1850, in which case we may infer that the change was going on in the same direction before that time and adjust the figures accordingly. Some allowance can be made here for certain known circumstances. In general, the ratio of farm land to population tends to decrease with the progress of invention and industry, as it has done in Massachusetts (from 3.4 acres per capita in 1850 to 0.9 acre in 1910); but in thinly settled regions, where lumbering and fishing were at first more important than agriculture, as in Maine (which had 7.8 acres of farm land per capita in 1850 and 10.1 in 1880), it naturally increases as agriculture develops. In Vermont the ratio varied very little between 1850 and 1910, and we can therefore carry the same ratio all the way back to 1790 with some confidence.

Whatever uncertainty there may be in this method of estimating the farm land between 1790 and 1850, the possible error in the total forest area is proportionately less, at least where the woodland is in the majority, as was the case in nearly every eastern state prior to 1850. For the seventeenth and eighteenth centuries, apparently the best we can do is to assume that the forest area decreased pretty steadily from the time of first settlement to the first census.

Of course some of the present farm land and urban area is in the 5 per cent originally treeless, which would give the forest a little advantage; but in New England (unlike Illinois) the overlapping of occupied and treeless land is very small, for much of the latter, like salt marshes, bogs, and alpine summits, is practically uninhabitable; and what little error may result from this overlapping is very likely more than counterbalanced by fields and pastures overlooked by the census enumerators on account of their owners having moved away and abandoned them.

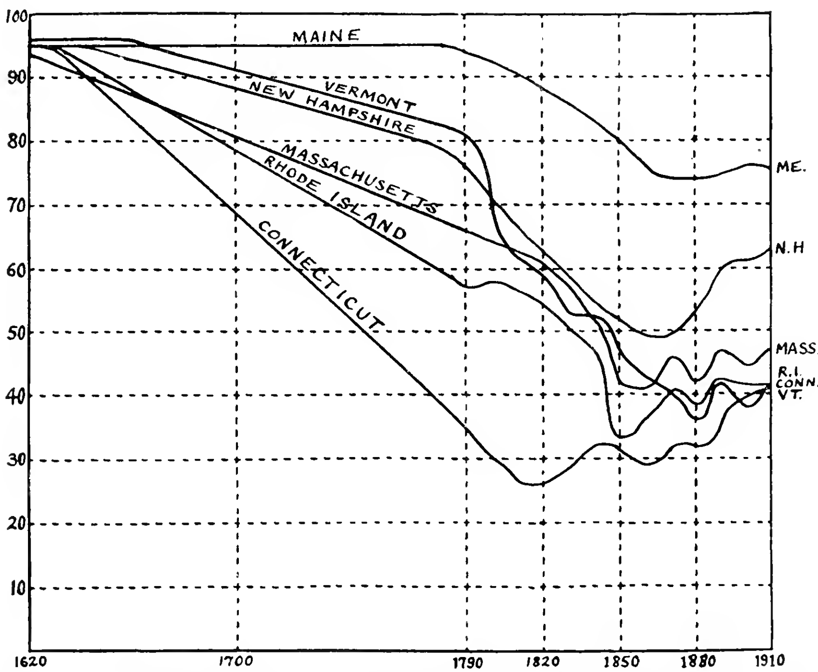

FIG. 1.—*Estimated percentage of forest area in each New England state from 1620 to 1910*

Instead of putting the results of all these computations in a table, with figures giving a deceptive appearance of greater accuracy than can be claimed for them, they are represented graphically by curves in the accompanying diagram, one for each state. Horizontal distances represent time and vertical distances the percentage of the total area supposed to be wooded at any time. If the computed figures had been followed literally in plotting these curves, there would have resulted some minor irregularities which would be confusing and probably not exactly in accordance with the facts; consequently they have been smoothed a little, though keeping the points determined for 1880 and 1910 (the years of the best censuses) fixed.

This diagram shows at a glance, better than a table could, the increase of forest land in all six states since 1880 and in most of them since 1850. The results for 1910 agree pretty well with those of Kellogg (1909) and Hawley and Hawes (1912), which were probably arrived at in a somewhat different manner. (The same method in some of the southeastern states, too, has given results quite in harmony with independent estimates.) It is interesting to note that the woods for which Maine has long been famous still cover about three-fourths of the state; that apparently no New England state is less than 40 per cent wooded, and that Connecticut seems to have more forest now than it had in 1790.

The next census, now about two years off, should show whether or not the New England forests are still spreading. An estimate of their percentage composition by species should be made at about the same time, and repeated every ten years or so, to show what trees are becoming relatively more abundant, and *vice versa*.[6] This is a matter that has not hitherto been considered as within the scope of a census, but it should present no special difficulty to any one who knows the different trees at sight. One person even in a few weeks of travel by rail and on foot should be able to get results accurate enough to show beyond a doubt what is the most abundant tree in a given state, county, or natural region,[7] and what species are more abundant in a given area than in an adjoining one—information that is almost wholly lacking at present.[8] And any desired degree of exactness could be attained by taking time enough. The quantitative data thus gathered would also assist materially in mapping the ranges of the species and determining their soil preferences—matters that we do not yet know as much about as we should. Where botanists are as numerous and transportation facilities as good as in New England, it ought to be possible to make a very complete forest census even before the next population census.

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[6] A remark in Kellogg's circular on the timber supply, previously referred to, is worth quoting in this connection. On page 3 he says: "Great as is the need for it, there has never been a timber census of the United States; nor, with one or two exceptions, any close estimate of the forest resources of any individual State. Such a census must eventually be taken to furnish the basis for permanent forest conservation." Since that was published some progress has been made, particularly in Connecticut, Maryland, Illinois, Alabama, and Florida.

[7] Probably the best existing map of the natural regions of New England is that in Hawley and Hawes' Forestry in New England (1912); but very likely it could be improved a little by taking into consideration some additional factors, such as soil.

[8] See Torreya, vol. 17, pp. 1-2; Bull. Torrey Bot. Club, vol. 44, pp. 39-40, 1917.

The foregoing remarks have dealt with forest area rather than with the amount of timber; and an increase in the former does not necessarily mean an increase in the latter. But at the same time that their complete eradication by the farmers has been indefinitely postponed, the inroads on the New England forests for other purposes have been diminished, partly by the same causes already mentioned and partly in other ways. A brief explanation will be appropriate to complete the story.

The pioneer settlers of any wooded region naturally build their houses of wood, except for the chimneys, etc. (and in some parts of the country those too are mostly wood). Fences, too, are required around the fields, and unless rocks are abundant (as they happen to be in New England) split rails or even stumps are used. At first the timber cut in clearing the land more than suffices for building and fencing purposes, and a great deal may be burned simply to get it out of the way.

Early in the history of New England timber began to be exported to Europe and other less favored regions. The straightest and tallest trees within reach of streams large enough for log-driving were long ago taken for masts and spars, which made Maine pre-eminent in ship-building for a long time. With the era of railroads and rapidly growing cities the lumber industry became very important in New England, and it has continued so down to the present time in Maine and New Hampshire, and has declined little, if at all, from its maximum in the other states. (In 1909 Massachusetts was cutting more white-pine lumber in proportion to its area than any other state in the Union.) The enormous increase in the use of wood pulp for paper in recent decades has been supplied chiefly from the boreal coniferous forests of northern New England and similar regions.

The use of wood for fuel has been one of the greatest drains upon the forests. Up to 100 years ago it was practically the only fuel used in the United States, and it is still used everywhere in rural districts away from the railroads. When steam locomotion was introduced, that at first increased the demand for wood. In the *American Journal of Science* (vol. 20, pp. 133-136), in 1831, which was just at the dawn of the railroad era, the editor viewed with alarm the vast consumption of wood by steamboats, and urged a more general use of coal, which was then a novelty. Fifteen years later, in 1846, G. B. Emerson, in his classic report on the trees and shrubs of Massachusetts, published by the state, estimated that the railroads in that state (500 miles) were using for fuel 53,710 cords of wood annually, and that the consumption was not likely to decrease.

Still other influences tending to destroy the forests, such as fire, might be mentioned, but enough has been written about them by others. The net result of cutting timber faster than it grows is not so much to reduce the area of the forest as to reduce the average size of the trees, each generation being cut at an earlier age than its predecessors. If the rate of forest exploitation in New England that prevailed about the middle of the last century had gone on increasing with the population, nearly all the forests would have deteriorated by this time to mere thickets, such as can be seen now in many thickly settled regions. Just how much the average size of trees has diminished can only be conjectured, for the early settlers were not particularly interested in measuring their timber, and we only have a few records of exceptionally large individual trees, such as might perhaps still be found in secluded places. And the diminution in average size probably proceeded so slowly that one person would not be much impressed by it, and each generation of inhabitants simply became accustomed to trees a little smaller than those their parents had known.

One of the most potent factors in diminishing the rate of consumption of wood in New England was the introduction of coal for fuel. Coal, which is lacking in New England, New York, and New Jersey, was discovered in Pennsylvania in the latter part of the eighteenth century; but it took some time to get people accustomed to it, and the facilities for bringing it to New England must have been very limited as late as 1846, when Emerson wrote of the large use of wood by the railroads of Massachusetts. But wood long ago ceased to be used for motive power by the railroads of the northeastern states; and we have become so dependent on coal for domestic purposes that just recently, in October, 1917, the Secretary of Agriculture found it advisable to issue a circular (No. 79), by A. F. Hawes (one of the authors of Forestry in New England), urging a more general use of wood on account of a temporary shortage of coal!

Within the memory of every adult person the use of substitutes for wood in many other lines has increased rapidly. This was at first mainly a matter of necessity, and the New England colonists probably began to build houses of brick and stone more than two hundred years ago, when the shortage of timber (due then mainly to inadequate transportation facilities, as explained below), was first felt. Within the last ten years, however, the substitution of other materials has been so rapid that the producers of some of the commoner kinds of lumber have spent large sums in newspaper and magazine advertising in an effort to stem the tide. According to Report No. 117 of the U. S.

Department of Agriculture, on the substitution of other materials for wood, by Rolf Thelen, published in September, 1917, the per capita consumption of lumber in the United States reached its maximum about 1906, and has since declined from 516 board feet per annum to 375 in 1915, which more than balances the increase in population, and thus makes a decrease in total consumption. The per capita consumption will doubtless continue to decline from now on, for it is still much higher with us than it is in most European countries. The use of wood-pulp has indeed increased greatly, from an insignificant figure in 1880 and 755,000 cords in 1889 to 4,470,763 cords in 1914, according to Thelen; but that has been many times offset by the falling off in firewood consumption, from about 146,000,000 cords in 1880 to 90,000,000 in 1910.

Efficient transportation has operated to preserve the forests of the northeastern states in still another way than those previously mentioned, but at the expense of other parts of the country. The vast pine forests of the South, and more recently the coniferous forests of the Pacific slope, which are among the densest in the world, have been made more accessible by numerous railroads, so that now lumber and shingles from those regions can be brought into the northeastern markets in successful competition with local material.

So, taking all things into consideration, the forests of New England and neighboring territory, at least in some parts and until some new factor enters into the situation, may be expected to increase still further in area and also in density. In northern New Jersey, which is much like some parts of New England, C. C. Vermeule came to the conclusion, in 1899,[9] that forest conditions had improved since the middle of the nineteenth century, and although he did not specially consider the westward migration of farmers, that has doubtless been one of the chief factors there, too.

More information on all these points can be found in the papers already cited, in the files of the various American forestry magazines, both technical and popular, and in the following works (which are arranged chronologically):

J. C. G. Kennedy: Agriculture of the United States in 1860 (Eighth Census) Washington, 1864. (See particularly pages xxxii-xxxiii and cxxxv-clix, on the grain trade.)

F. B. Hough: Report upon forestry [Vol. 1, for 1877]. 650 pp. Washington, 1878.

[9] Ann. Rep. State Geologist N. J., 1899 (Forests), pp. 18-23. 1900.

Nathan Allen: Changes in New England population. Pop. Sci. Monthly, vol. 23, pp. 433-444. Aug., 1883.

C. S. Sargent: Tenth Census U. S., vol. 9, pp. 494-501. 1884.

J. B. Harrison: The abandoned farms of New Hampshire. Garden and Forest, vol. 2, pp. 573-574. Nov. 27, 1889.

G. E. Stone: Past and present floral conditions in central Massachusetts. Rhodora, vol. 1, pp. 143-148. Aug., 1899.

A. K. Chittenden: Forest conditions of northern New Hampshire. U. S. Bur. Forestry, Bull. 55. 1905.

J. E. Defebaugh: History of the lumber industry of America. 2 vols. Chicago, 1906-1907.

F. W. Very: Devastation of forests in the White Mountains. Science II. Vol. 35, pp. 31-34. Jan. 5, 1912.

Hall & Maxwell: Uses of commercial woods of the United States: II. Pines. U. S. Forest Service, Bull. 99. 1912. (See particularly the section on white pine.)

J. P. Kinney: Forest legislation in America prior to March 4, 1789. Cornell Exp. Sta., Bull. 370, pp. 357-405. 1916.

L. O. Packard: The decrease of population along the Maine coast. Geographical Review, vol. 2, pp. 334-341. Nov., 1916.

A. E. Moss: A forest survey of Connecticut. Ann. Rep. Conn. Agric. Exp. Sta., vol. 39, pp. 197-232, 2 maps. 1916.

P. L. Buttrick: Forest growth on abandoned agricultural land. Sci. Monthly, vol. 5, pp. 80-91. July, 1917.

There are of course still other factors in the problem, but they are believed to be relatively unimportant, and cannot be discussed here without unduly increasing the length of this paper. It must also be borne in mind that New England is by no means a homogeneous area, for it contains not only a great variety of soils, topography, climate, and forests, but also almost every type of North American civilization, from pioneer to mature and decadent; and if one natural region, or even one state, should be considered at a time, some of the foregoing statements would have to be considerably modified to apply to it. But the general principles have perhaps been set forth sufficiently to show how profoundly the rate of forest exploitation in one part of the country may be affected by the development of transportation facilities in other parts.

REVIEWS

A Manual for Northern Woodsmen. By Austin Cary. Harvard University Press, Cambridge, Mass. Revised edition, 1918. Pp. 302.

Cary's handy manual has become a standard part of equipment for survey parties, at least in the Dominion Forestry Branch. With the addition of some thirty-odd pages, it still remains of convenient pocket size. The changes in the new edition are to be found in Part I, an extension of the azimuth of Polaris table, besides a few changes in style; in Part II, an addition of four pages on western topographic surveying methods with specially graduated tape and clinometer; in Part IV, ten pages detailing methods of timber-estimating in Pacific Coast forests; in Part V, some 15 additional tables, mostly volume tables, and a description of the use of the Biltmore Stick.

We would suggest to the author that the usefulness of the volume, now over 300 pages, would be enhanced by an index, especially as the subject-matter is not always to be found where one would look for it, as in the case of the Biltmore Stick, which comes at the end of the tables as a surprise, and much that appears under Forest Maps would be looked for under Land Surveying.

B. E. F.

White Pine Blister Rust. Compiled by H. A. Reynolds, Secretary to the Committee on the Suppression of the Pine Blister Rust in North America. January, 1918. Pp. 40.

This is a collection of brief reports regarding the condition of the white pine blister-rust problem in the various States, and the work done during 1917 in scouting and eradication, the reports being made by the officers in charge.

At the end Dr. Haven Metcalf summarizes the situation (which summary we published in the main in Vol. XV, pp. 1063 ff, and Vol. XVI, p. 85 ff).

Briefly, in the territory west of the Mississippi and in the South matters are not dangerous; in the territory between the Mississippi and Hudson rivers the situation is "on the whole hopeful," Ontario being the most dangerous element, for here the Niagara peninsula is generally infected and on ribes at least quite generally found through the Province; east of the Hudson River the situation "could hardly be worse," the only hope for the future growing of white pine lying in local control by eradication of ribes.

Aspects favorable for the control of the disease are first of all the fact that Geneva, where the disease was first found twelve years ago, is now entirely free from the disease after years of effort. Further, the fact that in Minnesota two large areas, and in Wisconsin and New York one each, and several small areas in Pennsylvania, Ohio, and Indiana, have been apparently freed from the disease is reassuring. Again, the progress of the disease is slow; the oldest infection—that in Kittery, Maine—is apparently fifteen years old; and yet the number of trees infected within the eradication area of three square miles does not exceed 10 per cent of the whole number, although the infection is complete in the immediate vicinity of the oldest infection.

"Still more hopeful for the continued growing of white pine is the fact that in areas where the disease is generally prevalent local control measures can be inaugurated at any future time by the elimination of ribes." In this connection we may point to the similar eradication of the wheat rust: it is in part a question of relative values of the two host plants and the cost of eradication.

The vigorous prosecution of the work of locating and eradicating the advance infections is recommended in the other territories.

Dr. Spaulding reports on the results of the scientific investigations during the past season. The over-wintering of uredo pustules on ribes seems demonstrated. No immune varieties have been found. Animals, especially insects, are apt to spread infection by carrying spores; on the other hand, squirrels and gypsy moth feed on the blisters and eat the infested bark, and in this way reduce the number of spores.

Brush disposal from cut pines is essential, since such brush carries the fruiting body through the winter.

B. E. F.

Foothills Vegetation in the Colorado Front Ranges. By Arthur G. Vestal. Bot. Gazette, November, 1917. Vol. 64, No. 5, pp. 353-385. Illus.

The study of the vegetation and plant geography of the eastern mountain front in Colorado has been carried on for some time by Vestal, first in the prairie and now in the foothills vegetation.

The foothills under study are covered generally with very open forest of western yellow pine and piñon-juniper, especially toward the south, but although these are the most conspicuous vegetational units the grasslands are the most wide-spreading and important. Mesophytic communities are rare and are limited to small areas, for although the rainfall is somewhat greater than on the plains to the east (18 to 20 inches) and evaporation is not as great, conditions remain rather severe on most sites.

A classification of habitats has been made based upon their degree of xerophytism, followed by a classification of the plant associations of the region. This classification is based on a number of features. The primary division is based upon the successional stage, whether primary and unstable or established in character; subsequent divisions are made chiefly on the basis of the site upon which the association is found and the form of the association, whether of trees, shrubs, or herbs.

The associations recognized are lichen, sumac, and foothills primitive grassland association as the first vegetation on new or unfavorable habitats, followed by rock pine (western yellow pine), piñon cedar, *Quercus cercocarpos*, Arctostaphylos, Ceanothus, foothills mixed grassland, bunchgrass, Pseudotsuga, *Populus salix*, canyon forest aspen, foothills mixed shrub, Symphoricarpos, and the foothills mesophytic grassland association.

Some of these are of particular interest. The rock pine (western yellow pine) association is very wide-spread and is found in a wide variety of sites. Its establishment depends chiefly upon favorable conditions during the critical period of the first few years of life. Small areas of soil deposition burying the seed often give rise to dense young stands. The effect of fire in this association has tended to restrict the pine and aid its shrubby associates, but the magnitude of the effect is difficult to determine. A frequent associate of the pine is *Ceanothus fendleri*; other conifers are usually rare.

The piñon-cedar association is prominent only toward the south, where, with the increasing aridity, the western yellow pine appears at higher altitudes, leaving the lower foothills to this more drouth-enduring type. A closed canopy is never found. There is little vegetation on the spaces between the trees.

The arctostaphyllos association, frequently considered as an almost constant companion of western yellow pine, is found to go very much higher than the pine and to be typically a formation of the montane region rather than the foothills.

The Pseudotsuga association is limited in the foothills to north slopes, where it forms small local stands of varying density. In the more open of these the western yellow pine is also usually found.

The canyon forest association is composed of mesophytic deciduous trees which generally grow to only small size, as alder, birch, willows, aspen, maple.

The aspen association occurs very rarely in the foothills region, being limited to permanently moist, cool canyon bottoms with deep, rich soil. In the montane region above it spreads into a much wider range of sites.

This study is a valuable contribution toward the stabilization of our conceptions of the chief associations in the Colorado front range foothills. Not until associations are blocked out, described, and differentiated as clearly as possible will it be possible to use their names in any definite sense, as is becoming so increasingly necessary in forest and ecological literature .

F. S. B.

Lärken och dess Betydelse för Svensk Skogshushållning. (The Larch and Its Importance in Swedish Forest Economy.) By Gunnar Schotte. Meddelanden från Statens Skogsförsöksanstalt. Häft 13-14, 1917, pp. 531-840.

This most comprehensive—indeed, monumental—and profusely illustrated monograph aims to state the results attained up to date in larch cultivation in Sweden. The main basis has been the sixty-six experimental plots of the State Institute of Experimental Forestry. The literature on the subject, foreign as well as Swedish, has been very fully made use of, and not less than 663 references are cited.

At the outset the author devotes some space to pointing out the special importance of introductions in the case of Sweden, owing to the paucity of species, the native coniferous forests consisting of only Scotch pine and Norway spruce. After a second chapter, devoted to a description and classification of the nineteen different species of larch, Schotte proceeds to a consideration of each species, most attention being given to the European, Siberian, and Japanese forms.

The treatment is in each case uniform, describing its introduction into Sweden and other countries, present occurrence in Sweden, varieties and races, silvicultural properties, regeneration and culture, thinning, productivity, insect pests and fungus diseases, properties and uses of timber.

The author considerately gives a 25-page résumé in English, with a summary which we quote in full:

In Sweden *Larix europæa, sibirica,* and *leptolepis* have been successfully cultivated as forest trees. During the last few years experiments have also been made with *Larix occidentalis.* Isolated specimens of *Larix americana* and *dahurica* have been cultivated in parks. It is further considered that experiments ought to be made with *Larix kurilensis,* and in the fell districts with *Larix lyallii.* As regards the more important species of larch, this inquiry has brought out the following points:

Larix europæa is cultivated over almost the whole of Sweden; in Norrland in somewhat isolated specimens as far as Pitaeå, and probably also in Haparanda. It is scarcely to be found in the inner parts of Upper Norrland. It began to be planted about 1750, but as a forest tree not until 1780-1790.

As a rule, larch plants were obtained from Great Britain, especially from Scotland. The older larch woods obtained from there are distinguished by a strikingly straight stem, strong growth in height, relatively thin bark, and a not very bushy crown. These characteristics are so very marked that we must distinguish a special Scottish race. From the middle of the nineteenth century, when forest culture in Sweden had spread greatly, owing to influence from German forest literature—on the estates of private persons, especially through foresters who had immigrated from Germany—larch seed came to be sent from the mountain districts of central Europe, probably more and more from the Tyrol.

The larch woods that have thus come into existence are characterized by a very high percentage of crooked stems, a somewhat weaker height growth, great thickness of bark, and often a rather bushy crown. These characters make the Tyrolean larch unsuitable for mixed forests. Thus the crooked stems of certain larch woods or certain individual larches are due to inherent race properties, and not, as was formerly assumed, to its rapidity of growth, as compared with other trees in the stand.

The larch can with advantage be cultivated in pure woods on the best forest grounds in Sweden. On grounds of the quality grades 1.0-0.4 for pine a mixture of larch with pine can advantageously be made, either in the form of individual trees or in small groups.

As appears from the stand survey in Table VII, this larch attains considerable productivity in a short time. On better ground the period for the production of a certain dimension of larch need only be two-thirds of that for pine; on poorer ground only one-half the same. On the worst ground of all—quality grades 0,2-0.1 for pine—the larch cannot be cultivated with advantage.

As the larch is to a great extent exposed to larch-canker all over Sweden, it should by preference be cultivated in mixed woods and especially by mixture with pine. Mixture with spruce ought to be avoided, and can only be tolerated with spruce as undergrowth. Larch with beech interspersed makes an excellent stand, for the European larch seed should be chosen from the Scottish and Silesian race, not from the Tyrolean race. The best thing, however, is to collect seed from the fine larch woods that already exist in Sweden.

Larch woods must be thinned early and heavily. The first thinning takes the form of a combination of high thinning and low thinning; then come heavy low thinnings and, if there is any undergrowth or it is possible to secure undergrowth, extra heavy low thinnings.

By this means the wood is made more capable of resisting larch-canker. As a preventive against canker, stripping the twenty to thirty-year-old trees of branches should also be tried. The stripping should take place in dry weather, and the brushwood should be removed or burnt up.

The European larch can be cultivated with advantage as far north as central Norrland, and should, by increased culture in the manner here indicated, contribute to a very considerably increased yield on the part of the forests.

Larch timber is of excellent quality, and suitable for piles, house-building, for power transmission and telephone posts, for sleepers and props.

Owing to the durability of the timber for these purposes, twice the price should be obtained for larch as for pine timber.

Larix sibirica can be warmly recommended for culture in the northern and central parts of Sweden, but preferably not south of north Västergötland and Östergötland. In comparison with the larch from the Tyrol, it is distinguished by a great percentage of straight stems. In this respect it is quite comparable with the Scottish larch. As this larch is attacked by canker as much as the Euorpean larch, and that, too, probably over the whole country, the same precautionary measures should be taken in its cultivation as for the European larch—mixed woods on moderately good and poor ground and possibly stripping of the lower branches. On quality grade 0.2 it is not worth while to cultivate this larch and on 0.1 it does not do at all.

In the south of Sweden its growth is probably weaker than that of the European species, and it is there more attacked by canker than that.

The timber is excellent and possibly still more durable than that of the European larch.

Larix leptolepis is suitable for culture in the southern parts of Sweden as far up as the vale of Mälar (about 60° N. lat.). In its youth it attains very great height and volume; but this probably abates somewhat earlier than with other larches. As this species also is attacked by canker, it should also be employed in mixture with other kinds of trees. It also bears somewhat more shade than the other species of larch. On the other hand, it is troublesome in mixed woods because of its bushiness. It can therefore scarcely be recommended except in pure stands on the best ground, if it is desired to obtain a great yield in a short time and then cut the stand early. It is also suitable as a preliminary culture. The timber is stated not to be so valuable as that of the other larches.

J. H. W.

PERIODICAL LITERATURE

FOREST GEOGRAPHY AND DESCRIPTION

Siberian Forests

Regarding Siberian forests little reliable information is at hand; hence such notes as Arnould furnishes on a section, namely, the province of Transbaïkalia, are welcome.

The province, located in South Siberia, east of Lake Baikal, fronting on Manchuria, is mountainous, with altitudes not exceeding 5,000 feet, the mountain chains (Jablon Range) forming the divide between the Amur and Lena rivers, running northeast to southwest, forming narrow steppe-like valleys fit for grazing.

The forests cover, with 80 million acres, about 65 per cent of the territory and belong mostly to State and Crown—one-eighth to the Cossacks and an insignificant share to the peasants. The population is less than one to the square mile—mostly herders, hunters, and fishermen. The principal species are *Pinus silvestris* (60 per cent on north slopes up to 3,000 feet, and at high altitudes *cembra* (10 per cent) and *Larix dahurica* (25 per cent). In the valleys around Lake Baikal, and also in mixture with the pines, *Abies sibrica* and *Picea obovata* form a small part of the forest cover. Broadleaf species are represented by white birch, aspen, *Populus suaveolens* on the brulés; as underwood, *Alnus frutricola* and several other small trees, among them a number of willows. The conifers reach in 150 to 200 years heights of only 65 to 80 feet and diameters of 12 to 18 inches, the larger figures for the Scotch pine.

Only the forests along the one railroad and navigable rivers are exploited, and much, of course, is burned. Most of the timber cut goes to railroad construction, boat-building, and military barracks and coal mines.

The forest administration is to sell at auction at an upset price, but in the usual absence of bidding out-of-hand rates are made at the estimated price or at a discount, prices varying with location (accessibility). The prices run for pine and larch from one-half to two cents per cubic foot; fir and spruce even less. If standing timber is sold, this is done by diameters at base; a 9-inch tree might be 30 cents, then an 18-inch tree would be $1.20, a 36-inch tree $5.50—an increase of 10 per cent per "verstock." Fuel wood sells at 20 cents to $1 per cord, according to location.

With these low prices and a confined market, the forest service, nevertheless, manages with an expense of around $40,000, to make a net return of $120,000.

Revue des Eaux et Forêts, August, 1917, pp. 225-228.

BOTANY AND ZOOLOGY

Structure and Development of the Plant Association

Two recent papers on plant ecology are worthy of consideration by American silviculturists, particularly those interested in the foundations of silviculture or silvics. Gleason's paper takes issue with Clements' recent monograph on succession: (*a*) In considering the unit of vegetation an organism; (*b*) in considering the unit of vegetation a climax and all the successional series leading to the climax; (*c*) in the complexity of the unit due to (*a*) and (*b*); (*d*) in the apparent exceptions, excluded from the unit by the limitations of the definition.

Most silviculturists will agree with the author that the analytical exposition of vegetation by Clements is too complex and too much overburdened by terminology. Gleason offers a series of general principles explanatory of the usual phenomena of vegetation and derived chiefly from his own observation. He states that these principles were derived synthetically rather than analytically. The principles enumerated are 28 in number, few of which are supported by illustration. They are embraced under the following heads:

(*a*) The individual concept of ecology.
(*b*) The environment.
(*c*) Migration and selection.
(*d*) The association, its size and boundaries.
(*e*) The structure of the association.
(*f*) Scope of the association.
(*g*) Succession.

Under "The individualistic concept of ecology," the author states:

"The phenomena of vegetation depend completely upon the phenomena of the individual. It is in sharp contrast with the view of Clements that the unit of vegetation is an organism, which exhibits a series of functions distinct from those of the individual and within which the individual plants play a part as subsidiary to the whole as that of a single tracheid within a tree.

"It is true that various analogies may easily be drawn between a unit of vegetation and an organism, but these analogies are always more apparent than real and never rise to the rank of homologies. For example, it is obvious that an association may appear on a new area, develop to maturity, and finally disappear; but these phenomena are in nowise comparable to the life history of an individual. A spore of *Rhizopus,* for example, given the proper environment, will grow to maturity and reproduce without the presence of any other living organism. The first pioneer species of an association, on the other hand, will merely reproduce themselves, and maturity of the association will never be reached unless its other species are also present in a neighboring area. Similar exceptions may be taken to all other analogies between the individual and the association, designed to demonstrate the organic entity of the latter."

Space does not permit the discussion of the various principles enunciated. It is stated that the great mass of ecological facts revealed by observation and experiment may be classified in different ways, and from them general principles may be derived which differ widely in their meaning or even in their intelligibility. The following is a summary of these principles:

1. All phenomena of vegetation—that is, of numbers of individuals—depend upon the phenomena of the individual plant.

2. The plant population of any area is determined by environmental selection of immigrants from the surrounding population.

3. Because of similarity of environmental selection and of available sources of immigration, areas of uniform vegetation are developed, known as plant associations.

4. Effective changes in the environment or in the surrounding population may lead to significant changes in the vegetation of an area. If these changes involve the establishment upon it of a new association, the phenomenon is known as succession.

J. W. T.

Bulletin of the Torrey Botanical Club, Vol. XLIII, Oct., 1917, pp. 463-481.

Ecological Terms

A paper by Nichols has for its purpose "to outline a plan of classification which it is thought will recommend itself because of its lack of complexity and because of the readiness with which it can be applied and to express the writer's view regarding the interpretation and application of certain ecological terms and concepts." In Nichols' interpretation the association, in the last analysis, represents the fundamental unit of vegetation and is defined as "any group or community of plants, taken in its entirety, which occupies a common habitat." He says, in terms of dynamic plant geography, it is further defined as "any stage in a given successional series." It is recognized that in the acceptance of the above definition the word habitat should be defined as precisely as possible. The author's definition of habitat is "any unit area in which the combined influence of the various external factors which determine the ecological aspect of the vegetation is such as to produce an essentially uniform environment." He further defines the habitat as any unit area in which the combined influence of the climatic, edaphic, and biotic factors is essentially uniform throughout. With this precise interpretation, he states that a salt marsh, a pond or a ravine, which frequently is characterized as a habitat, should be recorded rather as a series of habitats. By applying the law of the minimum to problems in local physiographic ecology, climatic factors need not be taken into account, since they are essentially constant throughout the region, the variable factors being chiefly edaphic, due to variations in soil and topography. In problems of regional physiographic ecology, however, the climatic factors are variable and must be taken into account.

J. W. T.

The Plant World, Vol. XX, Oct. and Nov., 1917, pp. 305-319 and 341-353.

SILVICULTURE, PROTECTION, AND EXTENSION

Planting Scotch Pine in Pennsylvania

Pennsylvania for many years has been far in advance of all other States in the extent to which silviculture is applied in the care and management of State forests. Professor Illick, in the article under review, not only discusses the use of Scotch pine in Pennsylvania forestry, but shows in a series of tables the extent to which the planting of trees on the State forests has been done each year since 1899. In 1916, 5,492,020 trees were planted on the State forests. Of the 22,045,311 planted to the end of the year 1916, approximately two-thirds were white pine. Next to white pine in the total number planted were Norway spruce and Scotch pine. The tabulation below gives the annual planting in Scotch pine in Pennsylvania since 1909:

Year	Number of trees planted
1909	74,404
1910	70,925
1911	98,576
1912	152,900
1913	91,050
1914	133,154
1915	18,775
1916	714,950
Total	1,354,734

The above tabulation emphasizes the fact that Scotch pine occupies a by no means unimportant place in tree planting for forestry purposes in Pennsylvania. In the reviewer's judgment, its use has been proportionately great in many other Eastern States.

Although Scotch pine is an important timber tree over its native range in Europe, in the reviewer's judgment it does not prove that it will do equally well in the United States. The forester is bold indeed who advocates the extensive planting of this exotic species anywhere in America. Professor Illick does an important service for Pennsylvania in emphasizing the fact that the successful growth and development of an introduced species depends primarily upon the closeness of the correlation between the silvical requirements and the site factors of the region where the trees are set out; also in discussing the peculiarities and demands of Scotch pine, which is now being used quite extensively in the United States in artificial regeneration. He points out that this species, next to Norway spruce, has the greatest latitudinal and altitudinal range of any of the European forest trees. He should, however, have emphasized the fact that no forest stands of this species have been brought to maturity in this country, and our judgment of the excellency of the species for use in this country is entirely based upon its juvenile growth. In the reviewer's judgment, the success already attained in securing admirable juvenile growth in plantations in Pennsylvania and elsewhere in America is not indicative of what will be the condition and yield of the stand at maturity.

The juvenile growth of this species near Mt. Alto, Pennsylvania, is excellent, as shown in the following table, which gives the annual height growth up to 11 years of average trees on Quality I sites:

Year	Age of trees (*years*)	Current height growth (*inches*)	Total height (*inches*)
1907	1	2.0	2.0
1908	2	3.0	5.0
1909	3	3.2	8.2
1910	4	4.0	12.2
1911	5	6.4	18.6
1912	6	13.5	32.1
1913	7	18.2	50.3
1914	8	23.3	73.6
1915	9	25.9	99.5
1916	10	30.6	130.1
1917	11	31.9	162.0*

* 13.5 feet.

Contrasted with white pine on the same sites, Scotch pine at 11 years of age averaged 13.5 feet in height, while white pine averaged but 9.2 feet.

The author, in concluding his discussion of this species for planting in Pennsylvania, does well to state that "there seems to be no special need for planting it (Scotch pine) extensively in Pennsylvania for forestry purposes. It may, however, be advisable to continue the planting of it until we understand the silvical requirements and preferences of the native pines better, especially upon sites with adverse growth conditions."

The article is well illustrated with photographs from American and European sources.

J. W. T.

Forest Leaves, Vol. XVI, December, 1917, pp. 87-90.

Reforestation of Waste Lands

Many instances of apparent success up to the pole stage have failed later, for reasons which cannot be explained. The author (Forstmeister Krause) concludes that the first planting on waste lands is only a preparation which in a few decades must be followed by final reforestation. Nature afforests gradually by different successions, and we must follow the same procedure. He therefore recommends a great reduction in the cost of first planting or sowing, not aiming to establish a full stand.

Aufforstung von Oedländereien. Zeitschrift für Forst und Jadgwesen, January, 1915, pp. 29-46. Reviewed in Forestry Quarterly, Vol. XIII, pp. 29-46.

Spacing of Spruce

Experiments with spruce in Wermdorf, Saxony, begun 50 years ago, show a great superiority of planted plots over those sown. The number of stems and total basal area were greatest on broadcast sowing, but here the superiority ceased. Of different spacings, the greatest total volume was reached at 2¾ feet, but the greatest timber-wood production at 3⅓ feet. The value produced, however, found by multiplying diameter with "stout-wood" production, is greatest for 4½ feet. The writer adds: "Who can doubt the superiority of planting over natural regeneration?" Height growth as well as diameter is favored by open position. The form factors indicate that shaft form also is not best developed in close stands, but in a more or less open position.

One scientific fact of note resulting from the experiment is the unreliability of basal area as a basis of judgment of production.

Forstliche Tagesfragen. Tharandter Forstliches Jahrbuch, 1915. Vol. 66, pp. 129-215. Reviewed in Forestry Quarterly, Vol. XIII, No. 3, pp. 387-389.

Airplanes for Forest Protection

Before the Quebec Forest Protective Association, Major Kennedy, of the Royal Flying Corps, discussed the adaptability of flying machines to forest protective service. According to his figuring, with rather extravagant salary list, he came to a charge of 2 cents a square mile, or 20 cents per lineal mile. The account was made up as follows:

3 hydroplanes (1 reserve) and shed........................	$25,000.00	
At 10 per cent interest and 6 months' use..................	13.88	per day
Daily flights of 5 hours for 6 months, 800 lineal miles, looking over 8,000 square miles—		
2 aviators, salary by the year, $7,000, or.....................	38.88	per day
3 mechanicians	12.00	per day
Petrol and oil..	16.80	per day
Total..	$81.56	

[This would make the cost nearer 1 cent than 2 cents per square mile.]

The speaker pointed out that only first-class machines should be used; that these should be "pushers," having the propeller in the back to give the observer in the front free field; that it should be a slow-flying, slow-landing type.

Equipped with a wireless telephone (not telegraph), this should make a first-class equipment for a large-enough concern.

Canadian Forestry Journal, February, 1918, pp. 1521-1524.

Restoration of Devastated Forests in France

Jolyet, in discussing the rehabilitation of the forests in the war zone, points out the propriety of introducing conifers, and tries to answer the question, what species to use, from the cultural and economic point of view.

He announces that in territory where conifers are not spontaneously present in the hardwood forest it is imprudent to plant them in pure stands. Altogether, from the economic point of view, the hardwoods should be preponderant, even as fuel not any more to be despised after the experiences of the war. He hopes also the distillation industry to develop more extensively.

Mixed forest is recommended to be grown in such a manner that after the conifers are utilized the hardwoods will form the forest—that is, a small number of coniferous trees in a hardwood base. This indicates primarily the choice of an intolerant conifer—larch or Sotch or black pine. The author breaks a lance for the latter pine, which has a poor reputation as regards the knotty material which it usually furnishes in pure stands, but which is corrected by mixture in hardwoods. Of tolerant conifers that recommend themselves, silver fir, Norway spruce, and Douglas fir are discussed. The small spread of crown of the spruce (not more than 25 feet diameter for old trees) is a characteristic which makes it available for this mixed forest type. The same characteristic appertains to the silver fir, even in a plains climate. In discussing the Douglas fir, the author distinguishes between the green and the blue (Colorado) variety. While the former is expected to have no more crown spread than the spruce, the blue form is credited even with less spread, owing to a pyramidal or columnar crown form, which is so characteristic that it distinguishes the two varieties. This habit and two other reasons—its adaptability to dry climate and frost resistance—recommends it above the green form from the Pacific. The author denies its slow growth except in early youth, in which it resembles the silver fir; he also denies its unadaptability to calcareous soils, and the greater expense for the seed he hopes to overcome by the "brotherly aid of the great Republic of the United States."

The author acknowledges that the recommended introduction of the pines—the Scotch for sandy, the Austrian for calcareous soils—is beset with the danger of insect pests, but thinks these can be taken care of, especially the lepidoptera, which can be combated by torches.

Culture des Résineux. Revue des Eaux et Forêts, February, 1918, pp. 25-31.

Advantages of Mixed Forest

In an extended discussion, E. Mer sings the praises of mixed forest for the fir forests in the Vosges Mountains, advocating the introduction of the Norway spruce. He summarizes the advantages of this mixture in nine propositions:

1. The risk of windfall and snowbreak are much decreased, the less endangered fir offering support to the swaying spruce and the roots of the latter having a chance for unobstructed surface expansion above the deep-rooting fir. The reduction of windfall reduces the bark-beetle damage. Where windfall occurs, it will not produce entire denudation of the soil, due to the presence of the fir and its reproduction.

2. The wind damage being overcome, a rational thinning practice becomes practicable.

3. Surer reproduction is secured and the mixture maintained if proper means are used.

4. A better soil condition is assured under the mixture than under pure spruce.
5. The spruce growing faster than the fir and the price being the same, a greater volume and value increment is secured.
6. The character of the wood is about equal.
7. The spruce is more frost-resistant and is not so liable to frost splits as the fir.
8. Due to its ability to grow in the open and rapidly outgrow weeds, the spruce is of value for planting in the clearings and too large openings in regeneration fellings. It is therefore the tree for reforestation except on unsuitable sites.
9. The species being the one tolerant, the other intolerant, they are mutually advantageous to each other, the first protecting the soil, the second enriching it by its abundant leaf-fall.

The author recognizes, however, some objections to the spruce. Wounds, even slight ones, exude resin and prevent wound-wood formation and give access to fungus disease. Red rot often spoils the value of the wood, although the author has found 200 to 250 year trees with hardly a trace of it. The bark beetle is another trouble. By proper precautions the troubles can at least be diminished. Methods of procedure are detailed.

Association de l'Epicéa au sapin dans les sapinières des Hautes-Vosges. Revue des Eaux et Forêts, December, 1917.

The Seeds of Forest Trees and Their Place in British Forestry

Taylor, in the article under review, states that the complete destruction of so many acres of British woodland, owing to conditions arising out of the war, has brought to the fore the national importance of forestry in a way that is practical and forceful. He states that it would seem impossible further to defer adoption by the State of a vigorous and comprehensive scheme of afforestation after 30 years of inaction, since a select committee was appointed by the Government to advise on the improvement of woodlands. In the report of 1909 it was recommended that 150,000 acres be planted annually. Somerville, in a more recent publication, mentions 300,000 acres as commensurate with the needs of the nation. Taylor states that if the latter program were carried out forest nurseries must be developed to grow 1,400,-000,000 seedlings and transplants yearly. Even if only carried out in part, there must necessarily be a large and sustained demand for forest-tree seeds; hence the consideration of actual and potential sources is of importance. Heretofore the requirements of British foresters for forest-tree seeds have been small and intermittent. The trade is almost entirely in the hands of continental collectors and dealers. The great increase in the demand for forest-tree seeds as soon as a definite constructive forest policy is adopted leads the author to the conviction that the development of a home-grown tree-seed industry should be encouraged.

As all trees are adapted to the conditions of their native habitat and possess the power to transmit the degree of adaptability acquired to the following generation, it may be taken that in all cases native seed of a given species is likely to prove the best.

As the indigenous sylva of the British Islands is poor in species, many exotics have been introduced during the past three or four hundred years, some of which have accommodated themselves thoroughly, while others have not. The uncertainty of seed produced by the latter has taught the forest nurseryman to be wary of home-grown seed. Exceptions are noted in species introduced from the Pacific coast of North America. It has been found that Douglas fir, Sitka spruce, western red cedar, and yellow cypress produce sound, fully matured seed in the British Islands, and there appears to be no reason why British-grown seed should not be made use of.

The writer states that British seed of pedunculate oak, sessile oak, ash (*F. excelsior*), beech, alder (*A. glutinosa*), sycamore, wych elm, hornbeam, birch, and Scots pine should be used and imported seed of exotic oaks, exotic ashes, chestnut, black locust, larches, spruces, firs, white pine, and Austrian pine. Pending further information, the question of home *versus* imported seed of West American species should be regarded with open mind.

Consideration is given to the source of origin, seed year, maturity, seed fall, collection, storage, extraction, testing and germination, pests, qualities, and costs. In the author's opinion, the chances of fostering a home trade in tree seeds is entirely dependent on the possible expansion of British forestry under government auspices. The tree-seed problem cannot be regarded too seriously, for errors in seed selection affect the physical and financial aspects of the crop throughout the whole of its rotation.

J. W. T.

Quarterly Journal of Forestry, London, January, 1918, pp. 28-43.

MENSURATION, FINANCE, AND MANAGEMENT

Results of Forest Management

In discussing the propriety of giving technical foresters of Switzerland a freer hand in the management of their charges, Biolley cites a definite example of the result of technical management. It refers to the communal forest of Boveresse, of less than 300 acres in extent, about 3,000 to 3,500 feet elevation, southeast exposure, steep, stony and rocky, abused and mismanaged, until the law of 1869 brought improvement, so that by 1891 a cut of 40 cubic feet per acre was possible. After that date a new working plan, after the *méthode du contrôle,* in selection forest came into operation and the conditions in 1892 and again in 1916, 25 years of management, show as follows:

	1892.	1916.	Gain, per cent.
Growing stock, total, cubic feet	38,275	43,815	....
Growing stock, per acre, cubic feet	335	383	14.0
Of this:			
Small sizes, per cent	39.4	27.2	—12.2
Medium sizes, per cent	46.7	48.2	1.5
Stout sizes, per cent	13.9	24.6	10.7
Volume of average tree, cubic feet	28	35	25.0
Increment, per acre, cubic feet	138	146	6.0
Cut, per acre, cubic feet	65	104	60.0

The last figure, which is still increased by thinning material to 115 cubic feet, presumably based on a sustained-yield calculation, is the most striking.

Schweizerische Zeitschrift für Forstwesen, November, 1917, p. 300.

UTILIZATION, MARKET, AND TECHNOLOGY

Cellulose Content of Wood

In a paper read before the Society of Chemical Industry on January 25, 1918, Dr. B. Johnsen and R. W. Hovey, of the Forest Products Laboratories of Canada, discuss at great length investigations into the cellulose contents of wood.

Wood chemistry as a whole is in a chaotic condition, because no standard method of investigation is developed. The authors describe their own method. From the tabulated results, it appears that there are striking differences in composition of coniferous and broadleaf woods, the latter giving a considerably larger yield of furfural, while the former yield more methyl-furfural.

It seems impossible with any of the present methods of analysis to extract only one uniform substance from wood. According to their resistance to various reagents, the non-cellulose constituents of wood are assigned to five or six groups of substances. The various investigators are apparently coming to the conclusion that the basal components of each substance are held together by physical (surface tension) rather than by chemical forces.

In the estimation of the cellulose content of wood by the Cross and Bevan chlorination method, the wood sample should be reduced to "sawdust" by rasping with a wood rasp until a sawdust is obtained that will pass an 80-mesh sieve, but which will be retained on a 100-mesh sieve. It is stated that "since Schorger (Jour. Ind. & Eng. Chem., June, 1917, pp. 556-566) found that the final cellulose still contained fragments of wood that had been only partially reduced, and therefore gave a strong methoxy reaction, it is not surprising that his values for cellulose were extremely high, and that great variations in the results were experienced.[1] Johnson and Hovey, writers of the article under review, are unable to agree with Schorger when he says that "in obtaining cellulose absolutely free from lignin the error involved by the destruction of the cellulose is out of all proportion to that caused by the presence of small quantities of lignin."

The writers propose a modification of the chlorination method in the estimation of cellulose, which is featured by a preliminary digestion with acetic acid and glycerine, thus hydrolizing the lower carbohydrates and furfural-yielding substances before the wood is chlorinated . The new method indicates a lower percentage of cellulose, aspen (*Populus tremuloides*) yielding 57.25 per cent, as compared with 60.95 per cent by the old method; red spruce (*Picea rubens*), 50.64 per cent (new) and 54.58 per cent (old), and balsam fir (*Abies balsamea*), 51.60 per cent (new) and 54.43 per cent (old).

In view of previous experiments (Pulp and Paper Mag. of Can., Vol. XV, 1917, p. 333), the variation in the cellulose content of a disc of balsam fir, as determined by Johnson and Hovey, is interesting. The cellulose content of the wood varied from 51.2 per cent in a sample taken in the sapwood to 54.15 per cent in a sample taken in the region adjacent to the pith, while the intermediate wood yielded 53.28 per cent. Sapwood of aspen yielded 51.24 per cent and heartwood 59.88 per cent. Rotholz in a disc of balsam fir yielded 39.42 per cent, wide-ringed wood from the same specimen 50.35 per cent, and narrow-ringed wood 52.85 per cent.

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[1] Schorger obtained his samples with a specially arranged saw or by scraping the wood with a cabinet-maker's scraper and shredding the shavings. Material that passed through a 40-mesh seive was considered satisfactory.

It is stated that, according to von Schrenk and Spaulding, the wood-destroying fungus *Fomes igniarius* affects the wood primarily by removing the lignin from the cell wall. Data presented in this article controvert their conclusions. The cellulose content of a sample of sound aspen was found to be 58.8 per cent and the lignin content to be 7.86 per cent. Samples taken from rotten portions of the same sample, attacked by *Fomes igniarius*, yielded 42.29 per cent of cellulose and 13.16 per cent of lignin.

In discussing the chemical composition of coniferous and deciduous woods, the writers state:

"The broad-leaved trees give a considerably higher yield of furfural than the coniferous woods, which latter contain much more methyl-furfural-yielding substance. This substance, or at least part of it, is apparently very resistant, as there always remains a considerable proportion of it in the residue. The commercial pulps likewise contain a large proportion of this substance, and it is interesting to note the high resistance of the methyl-furfural-yielding substance in decayed aspen. . . . Apparently there are considerable differences in the types of lignin substances of aspen and balsam fir which are especially characterized by their solubility in concentrated sulphuric acid. Klason's method of determining lignin by treatment with 72 per cent sulphuric acid is recommended for spruce, . . . and can be used with advantage with coniferous woods in general, but seems to fail entirely with broad-leaved trees." . . .

The writers' citation of Wislicenius' theory of the manner in which lignin is contained in wood is interesting, as he advances the hypothesis (Z. Chem. Ind. Kolloide, Vol. VI, 1910, pp. 1, 2) that the lignin represents colloids separated out from the cambium sap by adsorption, one part of which is reversibly and another irreversibly deposited on the cellulose. Klason (Svensk Pappers Tidning, 1916, p. 129) favors this opinion, and has determined that 6 per cent of the total lignin is reversibly combined with the carbohydrates of the wood.

B. L. G.

The Estimation of Cellulose in Wood. Pulp and Paper Magazine of Canada, XVI, January 31, 1918, pp. 85-93.

Wood-block Failures Analyzed

Wood-block pavements have given more trouble through excessive expansion and consequent heaving in cities in the Southern States than in other parts of the country. The fallacy of the sand "cushion" for creosoted wood-block pavements was pointed out as long ago as 1914 (*American Lumberman*, Jan. 24, 1914, p. 30). An extended investigation by the U. S. Forest

Service in 1917, which included the detailed examination of 62 pavements in different cities of the South, discloses the fact that almost all of the trouble experienced with this class of pavement was due to the use of sand "cushions" and fillers. Serious expansion troubles were experienced with 23 pavements in a lot of 35 that were constructed on sand "cushions" with sand fillers, while eight more of the lot were troublesome in a minor degree. In a lot of 30 pavements laid with bituminous filler, 20 on mortar and 10 on sand "cushions," none gave serious trouble and only four gave slight trouble. The method of treatment used—that is, specific gravity of the creosote, fractional distillation of the creosote, etc.—appeared to have little influence upon the behavior of the pavement toward expansion. Sand fillers are absolutely condemned and sand cushions are stated to be especially bad near car tracks. Pavements subjected to heavy vehicular traffic give less trouble than pavements in residence districts.

B. L. G.

Wood-block Pavement Failures of Southern Cities Analyzed. C. H. Teesdale. Engineering News-Record, LXXX, pp. 307-310.

Progress in Wooden-ship Design

It is asserted that the new "Kelez type" of wooden ship can be constructed with 20 per cent less timber, in 20 per cent less time, and with 40 per cent more of the labor unskilled than is required in the building of the conventional wooden ship. Moreover, an increase in cargo capacity of 20 per cent, on account of the square hold, is claimed for this type of vessel. The design incorporates the square hold of the tanker with the molded stem and stern of the standard wooden ship, the completed vessel presenting much the appearance of a steel vessel of the usual type. The most novel feature of the design is a central longitudinal bracing extending from the keelson to the deck beams in the form of a Howe truss, which greatly stiffens the ship and prevents hogging in heavy weather. A mid-section of the ship shows practically vertical sides extending to the knuckle strake, while the bottom from the knuckle strake to the keel is very flat. This simplifies the construction of the frames, and the planking, flooring, and decking can be placed by ship carpenters who have had only limited experience. Less timber is wasted in adzing and dressing these members, due to the simplicity of the design. A 98-foot vessel of the Kelez type has given exceptionally good service in Behring Sea—the wildest and most tempestuous offshoot from the Pacific Ocean. It is claimed that the adoption of this type of vessel will place the wooden ship on a more nearly competitive basis with the standard steel cargo carrier.

B. L. G.

The Ideal Wooden Ship for Inland Waterway and Coastal Service. Pacific Shipping, IV, February, 1918, pp. 5-6.

Stability of Wooden Ship-building Industry

Whether the wooden ship-building industry on the Pacific coast is to persist for some years after peace has been declared is a question of moment to the Northwest. Joseph R. Bowles, a prominent shipbuilder of Portland, Oreg., predicts that this industry will be non-existent one year after the war is over. Steel ship-building will, however, survive, due to the lower labor costs in this region, as outdoor industries are little hampered by severe weather conditions at any season of the year. An instance is cited of the building of two boats by the Government—one on Delaware River and one at Bremerton, Wash. The labor cost on the Bremerton boat is stated to have been lower by more than 12 per cent, despite the 5 per cent higher wage scale. Mr. Bowles pleads for the establishment of factories utilizing wood and turning out more finished products than rough lumber to make use of the labor that will become idle with the cessation of the wooden ship-building industry. He also asserts that the Northwest is a logical place for the rubber-goods industry.

B. L. G.

How Long Will the Ship-building Payrolls Last? Business Chronicle, IV February 16, 1918.

Rubber in Indo-China

The production of plantation rubber in Cochin China showed a marked increase during 1916, due to the maturing of many plantations established some years ago. Wild rubber is also produced in this region. Several species of lianas are tapped by the natives. Spots of bark are shaved from the vines, and as the latex exudes from the wounded cambium layer the native gathers it on his finger and wipes it into a small receptacle made of a hollow bamboo stick. The latex is allowed to dry in this receptacle and is then smoked and rolled into a ball. One native usually collects one kilogram of crude rubber in four to five days, for which he receives about $2.50.

The value of the wild rubber sold through the principal port, Haiphong, decreased from $661,420 in 1908 to $5,711 in 1915. This decrease is ascribed in part to wasteful methods of gathering, the withdrawal of German interests since the war began, and the competition of plantation rubber.

B. L. G.

Rubber in Indo-China. Far Eastern Review, Vol. XIII, December, 1917, p. 803.

Preservation of Piling

Recent experiments with a new and unique method of retarding the decay of uncreosoted piling in railroad trestles by means of common rock-salt have, according to Dr. Hermann von Schrenk, given promising results. Shallow wooden boxes are built around the tops of the piles, under the caps, fitting loosely around the piles. These boxes are kept full of rock-salt. The salt is slowly dissolved by rain-storms and is thus distributed periodically over the surface of the pile, retarding the growth of fungi. It is asserted that this method is especially applicable to the preservation of piles with thick sapwood that is especially subject to decay. Tests of the method in the treatment of yellow-pine piles in a railroad trestle, extending over a period of four years, have given favorable results.

B. L. G.

Salt Treatment of Timber Piles. Railway Maintenance Engineer, XIV, January, 1918, pp. 9–10.

Wood-pipe Design

In a truly remarkable article praying for standard specifications in wood-pipe design and suggesting a set of such specifications, J. F. Partridge asserts that redwood should alone be considered for permanent pipe lines. Douglas fir and pine are much inferior, for "they are pitchy woods, and it is impossible to obtain commercial-run lumber without sap, pitch, pitch seams, pitch-pockets, and knots." Again: "Sap and pitch in the staves mean a short life for the pipe, as deterioration will start first in the sapwood, pitch seams, or pitch-pockets. Pine and Douglas fir cannot be secured commercially without these defects." . . . Another gem culled from this article: "Douglas fir is the pipe that has failed, the oldest pipe having been built not more than 10 years, the greater number being of comparatively recent date." Mr. Partridge's description of kiln-drying methods in the Northwest is also interesting: "The old method of drying lumber (in Maine and Michigan) was by the use of live-steam kilns. These are still used in the Northwest for drying fir and pine, as such treatment is necessary in curing pitchy and sappy woods. The kilns are large rooms, along the floors of which are perforated steam pipes into which live steam is turned. The lumber placed in such a kiln is literally cooked." Just how the steam gives up its heat units without condensing on the lumber and wetting it instead of drying it is not explained by this eminent scientist. A forester reading this article can only come to the conclusion that the writer either has had no experience or training in wood utilization or that the gross misinformation in this article is deliberate. The discussion by other better-informed engineers in succeeding issues of the Proceedings brought out a mass of interesting and really valuable data on wood pipe and wood-pipe design.

B. L. G.

Modern Practice in Wood Stave Pipe Design and Suggestions for Standard Specifications. J. F. Partridge, Proc. Am. Soc. C. E., XLIII, April, 1917, pp. 559–595. Discussion, same volume, August, September, October.

Wood Creosotes in Wood Preservation

The toxicity of beechwood creosote, both crude and refined, has been investigated by J. C. Humphrey and his associates in the Bureau of Plant Industry at the U. S. Forest Products Laboratory at Madison, Wisconsin. It has been established that such creosote is two to four times more toxic toward wood-destroying fungi than coal-tar creosote. A later investigation has demonstrated that the toxicity of maple-wood creosote is practically identical with that of beech-wood creosote. Studies to determine the stability of such creosotes when exposed to the leaching effect of water or weathering will, however, be necessary before an accurate estimate of their value can be obtained from the data presented in this article.

B. L. G.

On the Toxicity to a Wood-destroying Fungus of Maplewood Creosote and Some of Its Constituents and Derivatives, Together with a Comparison with Beechwood Creosote. Journal of Industrial and Engineering Chemistry, June, 1917, pp. 567–569.

Preservation of Mine Timbers

Due to the present high prices of labor and material, wood for use in mine structures of a more or less permanent character should be creosoted. Though the best results are obtained from pressure processes, open-tank or brush treatments give economical returns in many situations. In the open-tank method of treatment, woods that are refractory to treatment should be immersed in a hot bath of creosote (150° to 200° F.) for one hour, and one hour in the cold bath (100° F.) for one inch of the largest cross-section. More easily impregnated woods require 15 minutes for each inch of the largest cross-section. Wood that is to be treated by this method must positively be seasoned until air-dry. Underground conditions in zinc mines do not warrant the use of creosoted timber except in special cases.

B. L. G.

Economic Importance of Wood Preservation. Engineering and Mining Journal, December 8, 1917, pp. 985–988.

Wood-destroying Fungi Resist X-rays

The rustic beauty of log buildings has led to the erection at various times of very pretentious structures, the largest of which is the Museum of the University of Washington at Seattle, Wash., which served as the forestry building during the Alaska-Yukon-Pacific Exposition in 1909. Due to the large sizes of logs used in this building, it was expected to remain as a permanent structure. Rapid decay caused by *Fomes pinicola* and *Polyporus schweinitzii* has made it evident that this building is destined to have a comparatively short life. Various attempts have been made to treat the logs to prevent further decay, with no success. The logs were not treated in any way before the erection of the building. Recent experiments with X-rays, submitting the wood to an erythematic dose, repeated as much as fifty times, failed to affect the growth of the fungus. Ultraviolet rays, long continued, also gave negative results.

B. L. G.

The Effect of Roentgen and Ultraviolet Rays upon Fungi. Phytopathology, VII, December, 1917, pp. 426–431.

EDITORIAL COMMENT

A few years ago Gifford Pinchot, in addressing the Camp-Fire Club of America, said: "Forestry in the State of New York is flourishing everywhere except in the woods." It looks as if the old order were about to change. Prof. A. B. Recknagel, of the Department of Forestry, at Cornell University, has been granted a year's leave of absence from his university duties in order to accept the position of Forester to the Empire State Forest Products Association; he took up his new duties on July 1 and has established headquarters for the association at Albany. The work which Professor Recknagel will undertake marks a new departure in the practice of forestry by private owners in the United States. The Empire State Forest Products Association is made up of prominent lumbermen and paper manufacturers in New York; the members of the association own upward of one million two hundred thousand acres of timber land in this State. The association, at its last annual meeting, decided to establish a rational and constructive system of forestry for the handling of these lands.

As President Schurman, of Cornell University, said in an address at Syracuse on April 6, 1917: "It is our national—yes, our international—duty in the present crisis to produce all we can and to learn to apply the principles of conservation to our distribution and use of the necessities of life." Forest products are now generally recognized as being emphatically among the necessities of life and are of increasing importance as the population develops. New York State is the largest consumer of forest products of any State in the Union, a recent report showing that over five billion board feet are consumed per year, with an estimated value of $107,189,225. The value of farm crops in New York in 1916 was placed at $293,329,000. The products from the New York State forests have steadily diminished in volume, until now they constitute less than one billion feet board measure per year. More than $65,000,000 are being sent yearly outside the State for lumber and a great variety of other products which could be produced within its borders.

These figures show the urgent need of managing the timber lands of the State with a view to continuous production—a need which is emphasized by the advent of war. The Empire State Forest Products Association, in taking up this work, feels that it is placing itself in line with the most patriotic and far-sighted industrial organizations. The action of the association will undoubtedly serve to stimulate other forest products associations in other States to follow suit. It is only by the practice of forestry on private holdings, which contain about four-fifths of the merchantable standing timber of the United States, as well as on State and Federal forests, which constitute the remaining fifth, that our forest resources will be adequately preserved. The democratic principles of our country indicate that this should be brought about by private endeavor rather than by governmental regulation.

In taking up this work, Professor Recknagel will have the benefit of years of practical training and experience in similar work for the Government in the United States Forest Service, coupled with four years' experience in teaching forestry at Cornell University. He has specialized in forest management and is the author of a book on "The Theory and Practice of Working Plans," the second edition of which has recently appeared. He is a graduate of Yale College, in the class of 1904, and of the Yale Forest School two years later. Subsequently he spent a year in study and travel abroad. He is on the Editorial Board of the JOURNAL OF FORESTRY and is a member of the Society of American Foresters.

NOTES

Forest Fires and the I. W. W.

Many editorial writers in the daily press and trade journals persistently asserted that the forest fires which burned last summer and fall in western Montana, northern Idaho, and eastern Washington were due to I. W. W. plotting. It is of interest, therefore, to state that as far as the fires on the National Forests were concerned, they were brought under control partly because a considerable number of volunteers for fire-fighting were found within the ranks of the striking I. W. W. lumberjacks. In Missoula, Montana, the local secretary of the I. W. W. organization even bore the honorable title of Government Labor Agent; he had sent more than a thousand strikers to the fires, even taking his pickets out of the St. Regis district to do it. The office of the district forester at Missoula recognized the efforts of the local secretary by a statement that "the leaders of the organization have urged their men to go out and help the Government fight the fire, and stay on this job until the flames are controlled."

Stub-burning Experiment

While working on the problem of utilization of old-growth hardwoods in the Adirondacks during the past winter, Prof. B. A. Chandler, of Cornell University, tried burning with gasoline the old stubs which it is not possible to utilize, even under the best of markets, but which are both a disease and fire menace. This method was tried at the suggestion of E. E. Brigham, Superintendent of Lands and Logging, Oval Wood Dish Company, Tupper Lake, N. Y. Mr. Brigham had used it successfully as a means of removing the stubs left after cord-wood jobs in the Lake States, where such stubs are a big fire menace.

Professor Chandler found that beech, birch, and maple stubs would all burn, provided punk of a certain character could be found, wet with a small quantity of gasoline and lighted. This punk represents a very advanced stage of decay, which dries out very quickly, and therefore does not freeze up when cold weather sets in. Since this punk is often on the inside of a hollow stub, a locomotive oil-can is the best thing in which to carry the gasoline.

Following are the notes on a few of the stubs burned:

Yellow birch stub. 15 feet high. 30 inches d. b. h.

Plenty dry punk at base. Bark covered with worm-eaten fungi.

Dec. 10, p. m. Lighted in punk wood near ground.

Dec. 11, a. m. Whole inside had burned out and two-thirds of shell had fallen over into the snow and was still smoking.

Hard maple stub. 40 feet high. 17 inches d. b. h.

Bark intact except for woodpecker holes. Covered with fungi.

Dec. 11, a. m. Lighted in woodpecker hole.

Dec. 12, p. m. No signs of fire left. Cleaned off bark for a three-foot strip and lighted at the lower end. Two hours later had burned over all the cleared area and was still smoking.

Dec. 29, p. m. Had burned to the ground.

Hard maple tree. 17 inches d. b. h.

Hollow, open at butt.

Dec. 11, p. m. Lighted dry, but snow covered punk inside. Was smoking slightly twenty minutes later.

Dec. 13, a. m. Had burned only dry punk or one-third area of cavity.

Beech stub. 20 feet high. 14 inches d. b. h.

Bark loose and two-thirds shelled off. Sap wood decayed but still firm. Center hollow. Several knot holes rotted through to center.

Dec. 13, p. m. Lighted in one of lower knot holes. An hour later whole inside of stub was a solid blaze coming out of the upper knot holes.

Dec. 29. Had burned to the ground.

Hard maple stub. 25 feet high. 12 inches d. b. h.

Bark tight except at top. Several short seams and limb scars open into hollow center.

Dec. 13, p. m. Put extra dose of gas into limb scar 4 feet above ground. An hour later whole inside of stub was burning.

Dec. 29, p. m. Had burned to ground.

While there are many stubs which cannot even be lighted, and others which will only partly burn, the method may be worth while in conjunction with other methods.

Industrial Use of Wood Fuel

When the wood-fuel campaign was first inaugurated, it was expected that the greatest increase in the use of wood would be practically restricted to the country, namely, the farms and small villages where wood could be conveniently hauled. Owing, however, to the acute shortage of coal, necessity forced a number of industries and factories to turn to wood for fuel which would not otherwise have considered it on account of the greater expense and less convenience of handling.

The use of wood fuel by factories reached its greatest development in New England, because this section was practically shut off for a time from all supplies of bituminous coal, which is the factory fuel. Therefore it was a question of shutting down entirely or using this substitute fuel which was at hand. Complete information is not available as to the quantity of wood used by the factories or how extensive its use was throughout New England, but it is known that a great many factories manufacturing various kinds of products were forced to use wood to keep in operation. One dealer reported that he had shipped 5,500 cords of wood to the factories in eastern Massachusetts. One of the factories, which normally used 50 tons of soft coal a day, used for a month in mid winter a minimum of 15 tons of coal and 50 cords of wood daily, and reached the conclusion that for steam production one cord of green wood is equal to seven-tenths of a ton of soft coal. The wood cost about $10 a cord f. o. b. the shipping point and the freight was about $1, with a dollar charged for piling in the yard and another dollar for carrying it into the factory. Stoking is considerably more expensive than with coal and one-third more boiler capacity is required when wood is used for fuel.

Such use of wood fuel will come about only through necessity, as it costs as industrial fuel at least three times as much as soft coal, although this increased cost is a small item compared to the overhead expenses and loss due to shutting down. The real reason therefore for using wood fuel is to keep the factories running.

This points to the fact that in wood fuel the country has a reserve or substitute fuel which can be drawn upon in emergency not only to supply domestic consumption, but to keep the factories running, although it may not be so efficient in the latter case as coal. Instead of waiting for emergency conditions to arrive, it would be well for both domestic and industrial users of fuel to plan on reserves in case the main reliance—coal—is not forthcoming.

Growth of Young Stands in Northern Idaho

The remarkable high current growth of Douglas fir on the Pacific coast, recorded in a recent number of the Journal, is almost equalled by western white pine at the Priest River Experiment Station in northern Idaho. One plot of these which was established in 1912, and remeasured in 1916, showed a current annual growth of 1,005 board feet per acre per annum. This plot had 1,350 trees per acre, of which 80 per cent were white pine, 5 per cent western larch, and 6 per cent

Douglas fir. The total loss of trees for the four years was forty-four, while there was an increase of sixty in the merchantable class.

Another plot consisting of young western yellow pine showed a current annual growth of 745 board feet, and two plots of Douglas fir gave 878 and 769 board feet per acre per year.

Effect of Sulphuric Acid Treatment on Seed in the Greenhouse Germination Tests

Tests were made at Priest River Forest Experiment Station, northern Idaho, to determine the effect of sulphuric acid treatment on the seed used in seed testing in the greenhouse. (Many nurseries use this treatment to prevent damping off of coniferous seedlings in the seedbed.) Seed of nine coniferous species were sown in duplicate series in sand in the wooden trays; one out of each series was treated by sprinkling a solution of sulphuric acid over the seed and sand after sowing. The acid was applied in a strength of 3/16 ounce to 3/16 gallon of water per square foot of surface. Twenty-two hours after this treatment abundant pure water was applied to wash the acid away from the seed.

It was found that the acid treatment destroyed a great portion of the seed, kept some of the seeds from germinating, killed others soon after germination, and prevented growth and development of those which came up. The smaller seeded and thinner-coated species suffered most. Thus yellow pine germinated 22 per cent less in the treated samples, lodgepole pine 86 per cent less, western larch 76 per cent less, western hemlock 97 per cent less than the treated samples, and the seed of western red cedar was entirely killed by the acid.

This large percentage of injury would not take place in the seedbed where the acid could be brought to a greater depth by heavy watering, but considerable damage would very likely be done to the lighter-seedbed species, such as cedar, hemlock, and lodgepole pine, by contact with the solution.

Very unusual weather conditions prevailed in western Montana and northern Idaho during the early part of January. The weather became so warm that the snow melted in the hills, and the streams attained a height usually reached only in June. Most of the logs which were banked in the river were driven down to their destination. The weather has, of course, had a very detrimental effect in preventing logging operations which were dependent upon sleigh haul.

Dr. James R. Weir, forest pathologist of the Bureau of Plant Industry, is now engaged in preparing some pathological rules for consideration in connection with silvicultural rules for the marking of timber in District 1. These rules will be one of the first concrete results of the pathological studies which have been carried out for several years.

Savenac Nursery is located on a transcontinental highway on the Lolo National Forest. It is the largest nursery maintained by the Forest Service. Like other administrative sites, the buildings have been constructed without any particular idea of the scenic effect. Extensive plans have been made for a rearrangement of the buildings, construction of a sewer and water system, and the beautifying of the grounds. On account of the importance of this activity and its very accessible location, particular pains will be taken to attract the attention and interest of visitors. The carrying out of the plans involve the expenditure of several thousand dollars, and it may take several years to secure sufficient money to finally complete the work.

A Forest Industry Committee was formed on October 13, 1917, at a meeting held at Berkeley, Cal. Its members are: G. M. Homans, State Forester, chairman; Roy Headley, Acting District Forester, representing the United States Forest Service; R. E. Danaher, president of the R. E. Danaher Pine Co., representing the lumberman's viewpoint; C. Stowell Smith, secretary-manager of the California White and Sugar Pine Manufacturers' Association, and Woodbridge Metcalf, representing the Division of Forestry of the University of California.

A large auction sale of Quebec timber limits took place last summer, bringing into the provincial treasury the sum of $380,000, an average price of $440 a mile for 800 square miles, exceeding by $100 the largest average yet obtained. In addition, the ground rent is payable in advance. About 5,000 miles were offered at this sale, but more than 4,000 acres were withdrawn, as no bid was offered over the minimum price. Payment is to be made in three equal instalments, the first cash, the second in twelve months, the last in two years, with interest at the rate of 6 per cent per annum.

The permit to cut will be subject to the laws and regulations now in force or to be enacted in future, and also on the following condition: The grantees of the aforesaid territory must within a delay of three years manufacture annually in the Province of Quebec, with the timber cut in this territory, either pulp or paper in the proportion of ten tons per day, or sawed timber in the proportion of ten thousand feet, board measure, per day, per hundred square miles.

There is legislation introduced in the legislature of New Brunswick which, if passed, will give that province a most advanced position in forest administration.

Features of this legislation are: an unpaid advisory forest commission of five, under the chairmanship of the Minister of Lands and Mines, with his deputy, the provincial forester, and two lumbermen; a forest service which takes over also the game and fishing interests and exercises the forest police; a technically trained forester, directly under the Minister, with a staff selected by examinations; a protection fund of $30,000 and a tax of one-half cent per acre collected from timber-license holders; this fund to be increased from other revenues to $100,0c0 annually, unused portions to form a forest protection sinking fund to be used for emergencies; sheriff powers for all permanent forest rangers.

A separate bill provides for forest-fire protection with great detail in not less than thirty-nine sections. Very careful detail prescriptions regulate the setting of fires and providing safety by burning of slash. All the experience in keeping railroad fires within bounds is embodied in nine sections. Compulsory assistance in fight-fighting is provided and suitable penalties for every infraction of the act.

Although forest planting operations in Oregon and Washington will be largely curtailed this spring because of war conditions, nevertheless the plans provided for planting on 1,732 acres, divided among five National Forests, from 140 to 470 acres in each. The species planted will be mainly Douglas fir and western white pine, grown at the Wind River Nursery on the Columbia National Forest, and a smaller quantity of western yellow pine grown at the Page Creek Nursery on the Siskiyou National Forest. Only the best grade of stock in the nurseries will be used.

In the Crater National Forest an old yellow-pine burn grown up to brush and unproductive is being restocked with yellow-pine seedlings in the brush, which is so dense that the planters can only work down the slopes. This planting is largely experimental, as the brush type of land presents new and unsolved planting problems.

So far, planting has been done in burns in the North Pacific District on 26,000 acres in Oregon and 8,000 acres in Washington.

During 1917 forest fires burned over 962,000 acres of National Forest, causing a loss of $1,358,600 to the Government in timber, forage, and young growth. Considering the unusually dangerous conditions, this is considered remarkably light loss. Protracted drouth and periods of high winds made the conditions virtually the same as in 1910, when many persons were burned to death and 25 million dollars' worth of timber on the National Forests was destroyed. Extra expenditures by the Government of $1,121,451 were entailed.

Of the 7,814 fires which were fought on the National Forests, all but 2,132, set by lightning, were caused by human agencies and could have been prevented. There were 952 incendiary fires, which occurred for the most part in Oregon, California, and Arkansas. Careless campers were responsible for 1,288. Railroads, partly through failure to comply with the law and use proper spark-arresters, set 1,003. The remainder were caused by various forms of carelessness on the part of settlers and other users of the National Forests.

A take-down, readily packed heating stove, devised by a member of the Forest Service in Missoula, Montana, will be tried out in the North Pacific District this spring. The stove is conical in shape, made of sheet iron, like the famous Sibley stove, but in three parts instead of one. The main body is divided longitudinally in two pieces, while the third piece fits over the small end, fastening the whole in position and providing the place for attaching the stove pipe. The stove is made for use on the ground, and has no bottom. The stove is two feet in diameter at the bottom and tapers to six inches at the top, where the pipe is attached. It may be made of any convenient size. A hinged door provides for the insertion of fuel. Draft is obtained by the simple process of digging under the edge of the stove at some point, the draft being regulated by making this opening larger or smaller, as necessity requires.

The Forest Service again co-operated with the Weather Bureau last winter in keeping a record of snowfall on the National Forests. From the data so obtained the Weather Bureau is able to approximate streamflow in the region for the succeeding summer.

The California Packing Corporation of San Francisco has been awarded the sale of 233,000,000 feet of timber on the Norval Flat-McCoy Chance, on the Lassen National Forest. Three bids were received, that of the successful competitor being 10 cents per thousand above the minimum. The prices to be paid are: For yellow, Jeffrey, and sugar pine, on the Norval Flat, $2.85; on the McCoy Chance, $3; for the fir on both, 50 cents per thousand.

A special meeting of bankers and members of investment houses was held by the Canadian Forestry Association at Montreal. Mr. Ellwood Wilson, Chief Forester of the Laurentide Company and chairman of the Woodlands Section of the Canadian Pulp and Paper Association, spoke on timber investments and their close relation to the need for better fire protection and improved methods of woods operations. The Canadian Bankers' Association gave the meeting hearty support, so that the turnout was excellent. Representatives of nearly all Canadian banks were on hand. Mr. E. L. Pease, president of the Canadian Bankers' Association, acted as chairman of the meeting.

E. I. Tinkham (B. S., Cornell, '16), who is with the U. S. Naval Aviation forces in France, recommends the airplane as "an excellent way of making rough timber estimates. One can clearly distinguish the different stands and types, and boundaries (in France) appear like distinct ribbons. For preliminary surveys over large tracts, two men in a plane could cover an immense amount of territory and get fairly accurate notes on topography, stands, etc. The use of the aëroplane in forestry bids fair to leave a wide range after the war, and I think it can have a broader field than fire-patrol work."

The first number of the *Montana Forest School News* has just been issued. The object of this publication is to "Keep the Campfire Burning" among the Montana Forest School graduates and ex-students, especially the forty-three members now in the military service in France.

Supervisor Erickson of the Crater National Forest has devised an auto truck for use in forest-fire work that carries not only men and outfit, but also pack animals.

The annual meeting of the American Forestry Association was held in Washington on January 9, 1918, and consisted of a formal meeting, without addresses or discussions, at the office of the Association.

The Empire State Forest Products Association (of which A. B. Recknagel, temporarily on leave from Cornell, is secretary) is now permanently housed in the *Journal* Building, Albany, N. Y.

Handboards are being put up in the Pennsylvania State Forests showing the boundary lines of State land, marking points of interest, and giving directions for travelers.

The Canadian Forestry Association has recently moved into new offices at 206-207 Booth Building, Ottawa, Canada.

SOCIETY AFFAIRS

Plans for the winter's program of meetings of the Missoula Section of the Society of American Foresters were discussed at a gathering on October 31, 1917. The scheme was approved of holding closed meetings at the homes of members at which the more technical papers would be presented, to alternate with open meetings to be held at the Federal building for the presentation of more popular subjects. It was decided to ask members of the section outside of Missoula to contribute papers to be read and discussed.

The forestry situation in Montana was discussed briefly in an endeavor to see what could be done to breathe some life into it. Preston was asked to present the matter at a later meeting when more time would be available for discussion.

The program, as finally drafted and carried out during the winter 1917-1918, follows:

Closed Meetings.—Montana Forestry, November 26, J. F. Preston; Review of Working Plan articles by B. Moore and Kirkland, December 17, Elers Koch; Review of Kirkland's article on the Lumber Industry, January 21, R. Parker; Brush Disposal Problems, February 18, H. L. Baker and W. M. Drake; Financial Aspect of Silvicultural Measures on Timber Sales, March 18, J. F. Preston; Taxation Problem on Forest Lands, March 25, F. G. Clark; Fundamental Principles Underlying the Margin for Profit in Stumpage Appraisals, April 15, J. W. Girard.

Open Meetings.—French Forests and Forestry, November 12, E. F. White; Analysis of the Fire Problem on a National Forest, December 10, C. M. Stevens; Present Labor Troubles in the Northwest, January 7, J. W. Girard; Revelations of 1917 Fire Season, District 1, Forest Service, February 4, R. H. Rutledge; Forest Products in the World War, March 4, C. L. Billings; Analysis of 1917 Fire Studies, April 1, C. C. Delavan; Solution of the Problem of Alienated Land on the National Forest, April 29, F. A. Fenn.

On March 13 twelve members of the Society met at Utica, New York, to form the New York Section of the Society of American Foresters. By-laws were drawn up and adopted. A resolution was adopted favoring the principle of yield tax in preference to the principle of soil-production value in forest taxation, intended to influence forest tax legislation now in the State legislature; also a resolution supporting the work of the white pine blister-rust campaign on the part of the State Commission of Conservation. The most important action was the formation of a committee to further the establishment of permanent sample plots.

The evening session, which lasted from 7.30 until a late hour, and the following morning session of four hours were entirely devoted to a discussion of experimental forest sample plots. The desirability of establishing such plots was taken for granted; no discussion on that point. A preliminary plan for collecting the desired data on sample plots was presented to the meeting, and it was discussed point by point throughout the evening. In the end it was decided to confine the sample-plot investigations to the determination of the actual increment after logging in feet board measure or in cubic feet on a unit area. This involves little beside the periodic measurement of height and diameter growth and the death rate in the different diameter classes.

It was recognized that sample-plot investigation, for purposes of convenient applicability, may fall under two heads, namely: (1) a simple record of what will happen under certain conditions, and (2) why it happens—why things are as they are. It was conceded that the lumberman is interested only in the data collected under the first head. He simply wants to know what the result will be in terms of another crop if he logs in a certain manner; he is interested only in results, not in causes. On the other hand, the forester who is charged with the management of the forest is interested both in results and in their causes, for he must modify the natural conditions, if necessary, in order to regulate the future yield. Therefore, it was decided at the conference to establish during the coming summer some thirty-five sample plots in the Adirondacks on which only growth increment and conditions for regeneration should be recorded through a series of years.

Co-operative arrangements have already been made with private lumber concerns and with the New York Commission of Conservation (on State lands) for collecting the data on the plots.

Later a much smaller number of plots would be established in the two principal forest types—the hardwood lands and the spruce slope—on which an attempt would be made to explain the causes for given conditions by a detailed study of the fashioning environmental factors, such as light, exposure, evaporation, character of the soil, insect and fungous diseases, etc.

A committee of five, one representative each from Cornell University, the New York State College of Forestry at Syracuse, and the State Conservation Commission, and two representing the lumber companies, was chosen and charged with carrying out the details of the sample-plot work.

This committee plans to select the sites and lay out the sample plots during the last half of May, 1918.

PERSONAL

R. S. Kellogg has resigned as secretary of the National Lumber Manufacturers' Association to become secretary-manager of a recently formed association among the paper manufacturers, known as the News Print Service Bureau, with headquarters in New York. The purpose of the Bureau is to disseminate information concerning the supply and demand for news-print paper throughout the United States and Canada, as well as abroad. It will also collect data upon the supply of all materials used in the manufacture of news print, the development of manufacturing processes, the study of scientific methods of cost accounting, and investigations into economic conditions affecting the industry.

Clinton G. Smith has been promoted from Chief of Silviculture in District 4 to Forest Inspector in the Branch of Silviculture in the Washington Office of the U. S. Forest Service. He is succeeded in District 4 by Chester B. Morse, formerly supervisor of the Targhee National Forest.

Fred J. Keuffner, of the Minnesota Forest Service, was killed at Washington, D. C., in an automobile accident just prior to the departure for France of the 10th Engineers (Forest), of which regiment he was a member. His untimely death has deeply touched the feelings of his many friends among the rangers and other members of the Minnesota Forest Service.

Forest Assistant J. R. Brownlie has recently been transferred to the Sioux Forest, in eastern Montana, where he will assist W. L. Baldwin in working up the data for a plan of timber regulation. The field and office work in connection with this project will probably take 12 or 15 months.

Dr. James R. Weir has recently returned from a two months' trip in the East. He visited Washington, Baltimore, Philadelphia, New York, and St. Louis, gathering data from universities and museums which will be of value in the pathological work which he is carrying on.

James H. Bonner, Acting Dean of the University of Montana Forest School, has accepted a commission as captain in the 20th Engineers. He is the third member of the faculty of this school to take up military duty. He is at Camp Lee, Petersburg, Va. Prof. R. R. Fenska has been appointed Acting Dean of the Forest School during the absence of Professor Bonner.

Scott Leavitt, Supervisor of the Jefferson National Forest, at Great Falls, has announced his intention to resign on March 1. Mr. Leavitt will be engaged in commercial work in Great Falls.

C. L. Billings, of Detroit, has been detailed for three months to the Arkansas Forest to take charge of a timber-survey party.

Reginald D. Forbes was appointed State Forester of Louisiana on October 1, 1917. His headquarters are at Baton Rouge.

H. D. Foster has been made Deputy Forest Supervisor on the Crater National Forest, at Medford, Oreg.

Dr. Henry S. Drinker was re-elected President of the Pennsylvania Forestry Association, and Dr. J. T. Rothrock, President Emeritus, at the annual meeting held at Philadelphia on December 10, 1917.

Frederick H. Millen has been promoted from the position of Agent for East Texas to that of Assistant State Forester of Texas.

C. O. Lerhardy, editor and manager of *California Forestry*, announced in the November issue of that paper that its publication would be discontinued for the period of the war. All of the staff have enlisted, Lerhardy himself being in the Naval Reserve.

J. H. Cunningham, of the Laurentide Company, has worked out an adaptation of the Dewey System of decimal classification designed to meet the needs of the pulp and paper industry.

Cedric H. Guise, instructor in the Department of Forestry at Cornell, has been granted leave of absence to permit him to become instructor in the Ground School of Military Aviation, located at Ithaca. He will teach the use of instruments and map-reading.

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THE YIELD OF VOLUNTEER SECOND GROWTH AS AFFECTED BY IMPROVEMENT CUTTING AND EARLY WEEDING

BY R. T. FISHER

The life history of the natural or volunteer reproduction which follows the usual portable mill operation of Central New England involves an enormous waste of potential lumber. This waste consists primarily in the elimination of the more valuable species of trees by the worthless or inferior. Such reproduction originates in part from seed falling at or near the time of felling; in part from stump sprouts, and in part from seedling and sapling advance growth, which was present in the previous stand. Coming after a clear cutting (which, for convenience in logging, includes most of the undergrowth, as well as the merchantable trees), the new crop is substantially even-aged. In composition, however, it exhibits such great variety as to make a classification into even secondary types extremely difficult. Nevertheless, there is a substantial percentage of young growth, amounting for the region under discussion to at least 20 per cent of the areas cut over, which, at the outset, contains the elements of a fully stocked forest of mixed pine and hardwoods.

The natural progress of such crops to maturity is well indicated by the accompanying photograph (fig. 1). This represents a stand which has followed a clean cutting of forty years ago. The original stand consisted of mixed pine and hardwoods over a hundred years old. The cutting was made in a seed year and was followed by a heavy reproduction of white pine. The balance of the new growth was furnished in part by hardwood sprouts and small advance growth and in part by seedlings of gray birch, pin cherry, and large-toothed poplar. The result of forty years of competition among the trees in mixture has been that practically none of the pine survived beyond the small sapling stage. The bulk of the valuable hardwoods, too, are in varying stages of suppression, and the dominant stand consists almost entirely of inferior trees, such as gray birch and poplar or poorly formed specimens of the better species.

This kind of deterioration is so wide-spread in second-growth forests and represents such an apparently preventable loss that it deserves analysis as an important problem of forest management. The purpose of this paper is to present the results of certain experiments, computations, and silvicultural experiences bearing on the practical possibility of increasing the final value of such forests by early weedings or improvement cuttings. In order to make comparisons significant, the

FIG. 1.—*Even-aged stand mixed pine and hardwoods forty years old*
Over 1,500 sapling white pines per acre dead or suppressed under weed species or worthless sprouts

study was limited to the same general association of species, namely, such second-growth forest on cut-over lands as had originated with (potentially) enough both pine and desirable hardwood reproduction to be fairly called a mixed pine and hardwood type. The data and material presented were all gathered on or near the Harvard Forest, in northern Worcester County, Massachusetts. This locality, though situated in the main white-pine belt of the State, is characterized also by a considerable number of hardwood species, due in part to a somewhat heavy soil and in part to being in a transition zone between northern and central forest types. The topography is, in general, a rolling upland or peneplain, ranging from 700 to 1,000 feet above sea-level, and featured mainly by shallow north and south trending valleys. The silvicultural conditions thus represent probably the keenest competition between white pine and hardwoods that occurs in New England.

In order to follow the life history of a typical stand of mixed pine and hardwoods, plots were located in four age-classes of this type, namely, at five, twenty, forty, and fifty years. It is, of course, possible in volunteer stands to find different areas with exactly the same composition, but the samples chosen are near enough alike for purposes of comparison and represent conditions very prevalent in the region.

TABLE 1.—*Summary of Reproduction*

Plot I. Area, 1/16 acre. Age, 5 years.

Species	Seedlings	Seedling sprouts. No. of clumps	Stump sprouts. No. of clumps
Red oak	38	21	1
Black cherry	180	5	..
Chestnut	19	8	9
White ash	68	54	4
Hard maple	33	9	..
Red maple	25	4	2
Gray birch	50	10	2
Large-toothed poplar	55	17[1]	..
White pine	62	...	..
Totals	530	128	18

[1] Root suckers.

The first plot examined (Table 1) shows what may fairly be expected as a volunteer forest following clear cutting. This table gives an enumeration of all trees, still growing and thrifty, five years after the previous stand was cut off. The cutting took place immediately following a heavy fall of pine seed, and differed from the ordinary commercial operation only in that the slash was burned after the logging and before the first growing season. The composition here shown is very nearly the same as that of the stand shown in the illustration (fig. 1). Although the white pine and many of the valuable hardwoods in this sample plot were still thrifty, they were already overtopped and plainly soon to be suppressed entirely.

It is in the older plots that the effect of the competition in height growth on the progress of wood production is chiefly to be looked for. By the time a stand is passing into the large sapling stage the relative position and condition of the crowns is a true index of the rate of growth and power of survival of the different trees. In analyzing these older sample plots the aim was, first, to show graphically the silvical condition of the stand, and, second, to get a basis for calculating the

TABLE 2.—*Basis for Calculation of Final Yield after Improvement Cutting*

Plot II. Area, ¼ acre. Age, 20 years.

Height (feet).	Species by tree classes: A, clearly dominant; B, overtopped, but still thrifty; C, suppressed or dead.																							
	White Pine.			Red Oak.			Red Maple.			Chestnut.			Black Cherry.			Gray Birch.			Poplar.			White Oak.		
	Stand before cutting (by heights)																							
	A	B	C	A	B		A	B	C	A	B	C	A	B	C	A			A	B	C	A	B	C
5	..	40	116	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
10	..	65	62	..	..	2	..	1	4	..	..	1	..	..	..	..	..	..	..	..	..	..	..	3
15	1	77	6	1	1	11	..	13	13	..	..	3	..	1	2	..	4	1	..	..	1	..	7	16
20	3	13	3	4	1	1	2	13	3	..	8	1	..	..	..	6	18	1	2	2	3	2	13	..
25	3	3	...	7	8	2	2	9	..	2	5	..	1	2	..	34	10	..	4	9	5	6	3	..
30	1	...	...	4	6	..	4	1	..	7	1	..	..	..	..	35	1	..	25	4	1	1	..	..
35	..	...	...	9	3	..	1	..	..	2	..	..	..	..	..	15	2	..	15	..	1	..	..	..
40	2[1]	...	...	2	1	..	..	..	..	1	..	..	..	..	..	..	..	..	4	..	..	..	..	..
Totals	10	198	187	27	20	16	9	37	20	12	14	5	1	3	2	90	35	2	50	15	11	9	23	19
D. B H. (inches).	Tally of trees cut (by diameters)																							
1	..	...	...	1	3	..	1	3	..	1	..	...	..	2	..	8	19	..	1	3	..	1	1	..
2	..	...	...	2	6	..	6	3	..	1	8	..	1	..	..	52	15	..	10	2	..	4	1	..
3	..	...	...	4	..	..	1	..	..	5	2	..	..	..	..	24	..	..	22	7	..	3	2	..
4	..	...	...	..	..	..	..	..	..	4	..	..	..	..	..	..	..	..	11	..	..	1	..	..
5	..	...	...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
6	..	...	...	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Totals	..	...	...	7	9	..	8	6	..	14	10	..	1	2	..	84	34	..	45	12	..	9	4	..

D. B. H. (inches).	Tally of trees left for final stand (by diameters)																						
1	..	84	...	..	6	..	1	12	..	..	..	..	..	..	..	..	..	..	..	..	..	6	..
2	..	28	...	1	1	..	1	1	..	..	1	..	..	..	..	..	..	..	1	..	..	3	..	..
3	7	1	...	7	1	..	2	1	..	1	..	..	..	..	..	..	..	..	8	..	..	2	1	..
4	..	1	...	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4	..	..	1	..	..
5	..	...	...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
6	1[1]	...	...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
7	1[2]	...	...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Totals	9	114	...	11	8	..	4	14	..	1	1	..	..	..	..	..	..	..	13	..	..	6	7	..

[1] Advance growth.

[2] 56 trees eliminated as certain to be crowded out in 10 years.

final yield upon two assumptions—one that the stand should remain untouched until maturity and the other that it should immediately be treated for the release and stimulus of the valuable trees through an improvement cutting.

Table 2 is a specimen of the form of record used for this purpose. It represents a quarter acre sample plot in a stand twenty years old. The upper section of the table shows all the trees on the area by species, by height, and according to whether they were (A) dominant, (B) overtopped but still capable of recovery, or (C) completely suppressed or dead. In the two succeeding sections of the table the same trees are listed by diameter breast high and separated into two classes—one for those to be taken out in the improvement cutting and the other for those which would remain to form the final stand. The section listed by height gives a significant representation of relative height growth. The two other sections of the table furnish the basis for the computation of final yield.

First, as to silvical inferences which can be drawn from the table. The site was, of all the plots dealt with, the poorest, being a flat, rapidly drained area on the edge of a small sand-plain. As such it was distinctly less favorable for the better hardwoods than any of the other situations considered. Nevertheless, at twenty years old, the majority of the white pines were less than 15 feet high, and the main portion of the dominant stand, consisting almost wholly of hardwoods, was over 25 feet high. The amount of true sprout growth was relatively small and the main stand was made up of large-toothed poplar and gray birch. Of dominant trees, 30 feet or more in height, there were 128. Of these, 95 were poplar and gray birch and only three were pines, two of which were advance growth that had escaped the previous cutting. From the point of view of silvicultural treatment, the significant thing was that about half the white pines on the area (trees of class B) were still vigorous enough to make normal growth if released.

The last two sections of the table show how the stand would be reduced if this release were carried out. The separation into trees to be cut and trees to be left was made after the stand had actually been marked on the ground for the necessary cutting. The computation of growth from this classification necessarily contains an element of silvicultural judgment, but one which is justifiably based on the results of similar cuttings carried out on the forest during the past nine years. In the first place, it was a question of judgment which of the overtopped trees were to be considered capable of resuming their normal growth after being released. No trees were put into this class about which there was any reasonable doubt, and in calculating their growth for the balance of the rotation five years were allowed for recovery from the condition of partial suppression—a period found in practice to be conservative. A further element of silvicultural judgment was involved in arriving at the number of trees of each species to be expected in the final stand at sixty years. This reduction was made on the ground at the time the plot was measured. Naturally, considerably more trees would be left after the improvement cutting than could survive to maturity, even though all were individually capable of thrifty growth. In the present case the number of trees left standing was arbitrarily cut down in accordance, first, with the relative crown development of each group, and, second, with the number of stems to be expected in a fully stocked stand at sixty years, as determined from local yield tables. The irregularity of crowns, inevitable in a volunteer forest, of course prevents exact uniformity in the density of the stand. The figures here assumed are at least conservative for the growing stock actually on the ground. The rotation was taken as sixty years; height and diameter growth were derived from model curves, based on stem analyses of normal trees accumulated over several years of field-work on the forest. The volumes were obtained from mill tally volume tables applicable to local usage and tested with reference to actual saw-mill output. The results of the computation of yield, first, for the plot if left to reach maturity without treatment, and, second, after having been given an improvement cutting, are shown in Table 3.

TABLE 3.—*Plot II—Summary of Final Yields at 60 Years*

Species	Final volume without improvement cutting			Final volume with improvement cutting		
	No. trees	Saw timber, bd. ft.	Firewood, cds.	No. trees	Saw timber, bd. ft.	Firewood, cds.
White pine..	9	2,689	....	60	7,165	....
Red oak ...	12	550	....	14	470	....
Red maple..	12	....	1.75	14	....	1.50
Poplar	33	....	1.75	9	445	.45
White oak..	8	....	.60	9	....	.30
Chestnut[1] ..	15	....	....	...	....	....
	89	3,239	3.10	106	8,080	2.25

[1] Eliminated as certain to die of disease.

The improvement cutting thus raises the final volume of saw timber on the quarter acre from 3,239 board feet to 8,080 board feet. This increase is almost entirely in pine, since most of the dominant hardwoods would be cut to make way for it. In addition, by removing heavy crowned trees and effecting a better distribution of those which remain, the cutting makes possible a higher number of trees per unit of area, a more complete utilization of growing space, and consequently a better quality of tree. The net result of the operation is to convert a stand which was prospectively composed of inferior hardwoods into one which would at maturity consist largely of white pine.

To show the tabulated records for the remaining older plots would require an unreasonable amount of space. Therefore, since with the type in question it is the final percentage of white pine which really

Fig. 2.—*Even-aged reproduction mixed pine and hardwoods seven years old, immediately after second weeding*

Species: White ash, white pine, red oak, and paper birch

fixes the value of the crop, the condition of the stand in the remaining two plots, as well as in that just discussed, is shown by a tabulation with respect to white pine alone.

Table 4.—*Total Number White Pines in the Several Tree Classes for all Plots, Showing Progress of Suppression as Related to Age and Site*

Plot	Age	A trees	B trees	C trees	Quality	Area
II	20	10	198	187	III	¼ acre
III	40	14	39	413	I	¼ acre
IV	50	24	24	141	II	¼ acre

In Table 4 are summarized the numbers of white pines on each of the three plots, according to the crown classification used above. There is also noted for each plot the quality of the site. Even making liberal discount for original differences in the number of trees per acre, this crown classification, taken in connection with the character of the sites, brings out some useful facts. The number of dominant, or A, trees is hardly significant, since it is largely a matter of accident how many individuals have been free from suppression from the start. The sudden drop in the number of B trees (overtopped, but still thrifty) between the twenty and the forty year age seems to indicate that any attempt at a profitable improvement cutting must be made before the twentieth year. In fact, considering conditions on Plot III, the cutting would probably have to be made even earlier. This plot represents soil of quality I—a site distinctly more favorable for hardwoods than for pines. The figures show that suppression proceeded here much more rapidly than on the lighter, sandier soil of Plot II. The 413 trees in class C were all dead, for the most part about twenty years old and between 10 and 15 feet in height. These were almost exactly the general dimensions of the B trees in Plot II, which, nevertheless, though completely overtopped, would most of them have survived from five to ten years longer on the poorer soil. It seems fair to conclude, then, that if a young mixed stand is to yield a substantial percentage of white pine it must be treated for release and improvement not later than the twentieth year, and still earlier on good soils.

Similar but less well-marked conclusions can be drawn with respect to some of the more valuable hardwoods in such mixed stands, but, being more difficult of decisive statement and less important in determining the final value of the stand, they are not here considered. Again, it should be noted that the several plots are not sufficiently uniform, either as to site or stocking, to make absolute comparisons possible. The results, however, are sufficiently large to be, in spite of this, conclusive.

TABLE 5.—*Summary of Computations for all Plots on Basis of Yield per Acre at 60 Years*

Plot	Age	No. trees	Final volume without improvement cutting: Saw timber, bd. ft.	Firewood, cds.
II	20	356	12,956 (pine, 60 per cent)	12.40
III	40	284	13,880 (pine, 60 per cent)	22.68
IV	50	320	12,820 (pine, 55 per cent)	8.50

Plot	Age	No. trees	Final volume with improvement cutting: Saw timber, bd. ft.	Firewood, cds.	Intermediate yield: Firewood, cds.
II	20	424	32,320 (pine, 85 per cent)	9.00	11.40
III	40	368	17,356 (pine, 75 per cent)	17.00	6.28
IV	50	332	16,064 (pine, 60 per cent)	2.50	7.12

In Table 5 are stated the final yields for each of the three plots on an acre basis, including the volume of mixed wood in cords derived from the improvement cutting, which, under average market conditions, would more than pay for the operation. For simplicity all species yielding saw timber were thrown together, but the per cent of the total represented by white pine is shown in each case in parenthesis. The figures show that the final yield of saw timber, at least on sandy soil, can be nearly tripled by a release cutting made about the twentieth year, and that thereafter the possibility of improving the final yield grows rapidly less. The figures do not indicate, however, what may be expected from proper cuttings made before the twentieth year, although

FIG. 3.—*Even-aged sapling stand two years after second weeding*
Species mainly white ash, red oak, and white pine. Forest weeds finally eliminated.

the obvious presumption is that an earlier cutting would produce a still better result, especially on the better soils. In stands less than twenty years old, where the effect of competition in height growth has not so completely declared itself, it is very difficult to make a crown classification on which a specific calculation of yield can safely be based. Nevertheless, it is possible to get a definite idea of the possibilities of earlier forest weeding by reference to operations and experiments carried out in young growth less than ten years old.

The destructive competition that takes place in a young mixed stand is not solely a matter of worthless species against desirable species or of rapid-growing against slow-growing trees. It is a matter of faulty physical arrangement of the whole crop. Enormous variations in height growth are exhibited by the same species, according to whether the individual stem is a seedling which originated under forest cover, or a sprout from such a seedling, or a sprout from a stump. Furthermore, the size and situation of the stump or stool itself involve still further fluctuations in height growth. Again, a vigorous and symmetrical sapling, such as would be abundant in the advanced growth under the previous stand, may by five feet of extra height at the start develop into a destructive wolf tree, even though itself of a valuable species. In other words, it is not possible to reduce the rates of growth and behavior in a stand of different species to the basis of an exact statement. Each individual tree has peculiarities of its own, and only the judgment of a person of experience can analyze a stand according to its prospective development.

The ideal silvical condition for timber production is a well stocked and evenly distributed stand of trees in which all are of valuable species and of such uniform height growth that the general crown canopy will develop evenly. An early weeding, therefore, should have for its object the best distribution of the best available trees and a uniformity of height and height growth such that there will be an early closing of the crown cover and the certainty that the desirable species will at least keep pace with any inferior trees that may have to be left.

TABLE 6.—*Average Heights up to Six Years Old of White Pine and the Sprouts of Six Associated Species*

Age, years	Average heights in feet							
	Red maple	Gray birch	Poplar	Red oak	White ash	Chestnut	Sugar maple	White pine
1	3	4	2½	2	2	3	2	...
2	5	7	4	4	4	6	4	.4
3	7	9	6	6	6	9	6	.8
4	9	10	8	7	7	11	8	1.5
5	12	11	11	10	10	13	11	3.0
6	14	12	16	13	13	15	13	4.0

Based on approximately 800 measurements. Quality, I.

Reference to Table 6 will show the difficulty of achieving this result. Speaking in general, the dominant new growth on a cut-over area will be between 12 and 15 feet in height (at the end of six years), when white pine of the same age and not retarded by overhead shade will have reached the height of only four feet. Furthermore, owing to dense and bushy development, the sprouts of desirable species like white ash may be quite as worthless in prospect as those of red maple. Between the two extremes of height growth, as represented by the hardwood stump sprouts at one end and the white-pine seedlings at the other, there will be a large amount of other seedling and sapling reproduction, as shown in Table 1, much of the best of which will be nearer the normal rate of white pine than the excessive rankness of the sprouts.

If the best results in the form of final value are to be achieved, it is plain that the first weeding must be applied earlier than the sixth year, since by that time suppression of the more valuable elements in the crop is already well under way. On the other hand, if the first weeding is made too early, the smallness of many of the seedlings and the rankness of herbaceous growth may render impossible a proper recognition of the true composition and promise of the crop. In addition to the most favorable date for the first weeding, it is also highly important for the forest manager to know how often and how many times the operation will have to be repeated. The proper date for the first weeding should coincide with the time when the reproduction is large enough to be fully recognizable in detail (*i. e.*, as to species and condition) and before any of the more valuable trees have begun to be seriously suppressed. Experience on the Harvard Forest indicates that this time is during the third or fourth year. The frequency with which the crop will have to be treated depends both on its composition—that is, how vigorous and numerous the desirable trees are in comparison with the undesirable—and, second, on the quality of the locality. The better the site the more rapid and persistent will be the growth of the hardwoods that must be eliminated. The general object should be to maintain the largest possible proportion of valuable trees in favorable growing condition until they have reached a size and rate of height growth that will enable them to keep even with or ahead of the weed element in the stand.

TABLE 7.—*Current Height Growth for last Two Years in Even-aged Sapling Stand Eight Years Old and Twice Weeded*

Species in mixture	Seedlings, height growth, feet		Seedling sprouts, height growth, feet		Stump sprouts, height growth, feet	
	1915	1916	1915	1916	1915	1916
White pine	1.2	1.4	...	...	...	...
White ash	.5	.3	.8	1.0	...	...
Red oak	...	...	1.1	1.7	...	...
Sugar maple	.6	.9	...	...	1.0	1.4
Red maple	.7	1.4	...	...	2.0	1.6
Black cherry	.9	.7	...	...	.8	1.0
Chestnut	1.5	1.0	...	...	1.3	1.6
Paper birch	...	...	1.6	2.1	...	...
Gray birch	...	...	1.5	1.1	...	...

Based on measurements of 245 trees. Average number per acre, 2,500. Average height, 6.4′; range of height, 4.2′ to 11′. Quality, I.

In the case described below this equality of height growth seems to be reached after the eighth growing season and in consequence of two weedings. The figures in Table 7 apply to the same cut-over area from which was taken the summary of reproduction in Plot I. They represent, however, not a single plot, but measurements taken at random. The young stand was first weeded at the end of the fourth growing season. Three years later the forest weeds had again reached a sufficient height and rate of growth to threaten the progress of the trees which had been released. A second weeding was therefore carried out. The measurements given in Table 7 were made two years after this second weeding, with the purpose of showing how near the current height growth of the trees selected for the final stand had come to equaling the height growth of the weed trees, already twice cut. Comparison of the rates shown in this table with those in Table 6 will show that, in general, the desirable trees were making height enough to keep them ahead of all but a very few of the weeds. It is reasonable, therefore, to conclude that two weeding operations applied before the seventh year will suffice to set free 70 to 80 per cent of the selected trees.

The cost of the weeding, described above, and of a number of others carried out during the same period is many times justified by the final return. On the basis of wages obtaining at the time (1912-1916), it cost from two to two and a half dollars per acre for each weeding. A person used to the work can easily accomplish from an acre to an acre and a half a day. Making proper allowance for necessary supervision, the costs to date for the two operations can be put at $7.50 per acre. Assuming that the crop was thereafter in condition to prosper without further treatment, this amounts to having secured a highly valuable reproduction for less than the average cost of planting an acre of pine. At present prices this cost would undoubtedly be increased by from two to three dollars; but, on the other hand, the prices of all kinds of timber yielded by wood lots have also risen sharply. Average white-pine box boards are now bringing at least $27 a thousand feet; second growth red oak, $30 and upward; even red maple, sound and straight, brings $20 at the factory. These prices all apply to timber between fifty and sixty-five years old and to qualities of lumber which are inferior to what might fairly be expected in the well-stocked stands resulting from early release cuttings. That superior straightness and uniformity can thus be brought about is plain to see in fig. 2, which illustrates the condition of the reproduction summarized in Plot I after nine years of growth and two weedings. On this particular area the unusual vigor and density of white ash made it desirable to favor that species at the expense of pine; hence the comparative scarcity of the latter species. Assuming, therefore, that two weeding operations carried out before the seventh year will produce in an equally abundant reproduction an even higher yield than that produced by improvement cutting at twenty years, as shown in Plot II, it is safe to count on 35,000 feet of saw timber to the acre at a rotation of sixty years. Giving this a value on the stump of $12 a thousand, the crop will be worth $420. If the quality of this timber is better than average as regards only 10 per cent of the volume, it would increase the total selling price in the present market by from $50 to $75, so that it is safe to put the final return from the crop at at least $500. Compare this figure with the final value of the stand considered in Plot III, which stood on the same quality of site and contained at the start very much the same representation of species in the reproduction. The final value of the stand on this plot, left without improvement, amounts in round figures to $175 per acre. Thus, by applying two weedings at a combined cost of approximately $10 per acre, the actual final return from an acre of mixed volunteer reproduction can be increased by $325.

Naturally, such results as these can only be expected in case of a well-stocked reproduction containing an abundant element of white pine. Nevertheless, it is the fact that from a fifth to a quarter of the areas cut over in central New England do reproduce fairly well to pine, and a much larger proportion are well stocked with valuable hardwoods, many of which are now almost as valuable as timber trees. When one considers that this region possesses unusually good local markets for practically every kind of lumber, and that these markets are constantly improving, it seems clear that no silvicultural process can more favorably affect both financial returns and forest production in general than early and systematic weeding.

TROPICAL FORESTS AND THE WAR

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The war is making necessary an inventory of the raw materials of the world. Not only will there be an enormous demand for reconstruction purposes in the war zone, but there will be an increase in practically every country in the world, for many normal peaceful pursuits that would ordinarily use raw products have been slowed down to make way for war necessities. This applies especially to the industries that are wholly or partially dependent upon wood. In the United States, for instance, larger quantities of lumber will be needed by the railroads, the building industries, furniture factories, and many other wood-working industries. In almost every other country the amount of lumber used locally, except that for war purposes, is less than in normal times. Where is this increased quantity of lumber going to be obtained? It is the purpose of this paper to discuss the rôle that the tropical timbers are likely to play in the readjustment of the world's demand for timber.

In the first place, the greatest demand is now and will continue to be for the so-called softwoods, or conifers, which, with some exceptions that are to be noted later, are found mostly in the temperate regions of the northern hemisphere. Besides the inherent qualities of these woods, which are those of lightness in weight combined with comparatively great strength and stiffness, they are easily worked, and the trees producing them occur in pure stands which permit the use of labor-saving machinery. In the coniferous forests, especially in the United States and Canada, there has been developed the greatest lumber industry that the world has ever seen. The coniferous woods can thus be placed at tide water at a low cost, and hitherto, because of cheap water transportation, they have been distributed to practically all parts of the world and compete successfully in price with the local woods. Prior to 1914 some two billion board feet of these woods were consumed annually in the tropics, the south temperate regions, and southern China, all practically non-coniferous-producing regions.

The character of tropical forests, especially with regard to their composition and the nature of their lumber products, has been generally misunderstood by dwellers of temperate regions. Most people believe them to be very complex in composition and to contain only hard and very hard woods that cannot be generally substituted for the soft coniferous woods. It is true that from the standpoint of a botanist they are very complex in composition—and to one unacquainted with the nature of tropical forests the botanists' reports are likely to be misleading. In the first place, in contrast with temperate regions, the great majority of the species are woody, either trees or woody vines (lianes). Moreover, the tree species of the forest can usually be arranged into four different irregular stories, depending on the size each species attains when it is mature. The height of the different stories differs according to the forest considered. In forests where the climatic and soil factors approach the optimum for forest growth the lower story is composed of tree species which when mature have a height of 15 to 30 feet. These, together with the immature trees of the upper stories, make this story most complex. The second story has trees, say, from 31 to 60 feet in height, the third those 61 to 100 feet, and the top those that are over 100 feet, and in some instances up to 150 feet. In each successive story from the lower up the number of species that have the inherent power to reach the higher stories when mature becomes less; so that the top story has fewer species than the third, the third less than the second, and the second less than the first. Obviously, the lumberman in sizing up the forest from its capacity to furnish timber would consider the trees of first and second stories, and in some instances the third story, as weed trees, just as he would consider the undergrowth of a typical deciduous forest in temperate regions as not worthy of his consideration as producing lumber. Naturally, complexity of the upper story varies according to the quality of the site on which the forest grows. On many habitats the upper story consists of scattered trees here and there that project the whole or a part of their crowns above the general level of the story beneath, thus giving the profile of the forest an uneven appearance. In such a case, if the other species of the lower stories were removed, the forest would have an appearance not unlike the park forests of the western yellow pine. Sometimes this upper story is made up entirely of one species, or for a given region there may be as many as 12 to 20 species. Usually, however, it is quite simple in composition. I observed a striking example of this on an island off the west coast of Mexico, where at least 90 per cent of the individual trees were of one species, known locally as palo prieto. The remaining 10 per cent comprised a large number of species with scattered individuals here and there. On the flood-plains of the Magdalena River the cotton tree (*Ceiba pentandra*) forces itself on the observer by its symmetrically rounded top. In places this tree would constitute at least 50 per cent of the stand, with the remaining 50 per cent made up of a large number of other species.

The sal forests of northern India are in this class, the sal forming almost pure stands of the upper story. Other dipterocarp forests of the Indo-Malay region are of this character, but sometimes the canopy of the upper story is closed or partially closed, so that the profile is more even. Such is usually the case on the best sites for forest growth. One of the best examples of such a forest that has come under my observation is in northern Negros, Philippine Islands (1). Here the canopy of the upper story is almost completely closed. This makes the volume of such a forest greater per acre in contrast with those where the trees of the upper story are further apart. From cruises the number of trees 16 inches and over in diameter is estimated to be 81 per hectare, of which 73 trees, or 89 per cent, are divided among six species, all members of the dipterocarp family. Moreover, the woods of five of these species were so near alike that they were placed on the market and sold as two woods. The remaining eight trees per hectare were scattered among many different species, some of which when mature, although reaching a diameter of over 16 inches, were short-boled and would be classed as trees of the third story. This forest contains an average of 30,000 board feet per acre of the dipterocarp timbers alone. In my paper on the dipterocarp forests of the Philippines, it is shown that cruises made in many parts of the Islands demonstrate that the actual volume of lumber in the dipterocarps alone will vary from 54 to 95 per cent of the total stand of timber. Foxworthy (2) states that in British North Borneo "seven of the ten most abundant commercial woods belong to this family (Dipterocarpaceæ), and areas which have been studied in detail show 60 per cent of the volume of trees over 16 inches in diameter to be of this group." My hurried observations in the Federated Malay States, and even in the so-called teak forest of Burma, showed that similar conditions obtain. Dutch foresters have told me that the dipterocarp timbers of the Dutch possessions in Sumatra and Borneo are more abundant than all the others put together. The character of the woods of this family will be discussed in another connection.

In South America the low-lying region beyond the reach of the annual floods of the larger rivers is known as the "terra firma." Recently I had occasion to see something of the terra-firma forests of the Magdalena River some 480 miles from the coast. The upper story of this is more compact than were the forests of the flood-plains. In places the canopy of the upper story was almost completely closed and was thus not unlike the dipterocarp forests of the best type in the Philippines. The stands of timber in the stretch of forest that I passed through would average 20,000 board feet per acre and large areas would average much higher than this. After a little study of the forest, it soon became apparent to me that one species (possibly two), known locally as coco de mono (English name, monkey pot), was the most common large tree in the forest. I counted hundreds of these trees, while numerous other species were represented by a few individuals. Among these can be mentioned the cedro, or Spanish cedar (*Cedrela bogotensis*), and mahogany (*Swietenia macrophylla*). Of the former I counted 13 mature trees and of the latter only two. The monkey pots belong to the genus *Lecythis* or closely related genera and are members of the Brazil-nut family (Lecythidaceæ). The monkey pots form at least 40 per cent of the volume of the forest. In the low foothills of the eastern range of the Andes bordering the river plains, mixed with the monkey pots is another species of the same family. This is *Cariniana pyriformis*, known locally as albarco and in the United States as Colombian mahogany. These two species alone constitute a very large percentage of the volume of the forests.

Anderson (3) in one of his studies of the forests of British Guiana summarizes tree counts on a large number of "sectional surveys" in a forest which he calls "forests clothing the plains and hills of the slightly elevated country." This habitat evidently corresponds to the "terra firma" of the Amazon and Magdalena valleys. The counts show that out of an average of 133 trees to the acre, 30.5 trees, or nearly 23 per cent of the stand, were composed of kakaralli, the local name for the monkey pots (*Lecythis* spp.). Three other species constitute 21 per cent of the stand, making in all for the four woods nearly 44 per cent of the stand. In another type of a forest which he calls "forests of the swamp lands" his count shows that one species, mora (*Dimorphandra mora*), constitutes nearly 30 per cent of all the trees; the first two species on the list compose nearly 40 per cent and the first eight species 68.5 per cent of the total.

Huber (4), in his description of the "terra firma" forests of the Amazon Valley, mentions Lecythidaceæ as one of the most important families producing a number of species that have a place in the upper story. From his description I infer that the canopy of the upper story is not closed entirely, but contains trees which reach a height of from

30 to 50 meters. Among those that are especially mentioned besides the Brazil-nut tree (*Bertholettia excelsa*) are species of *Lecythis*, *Cariniana*, and *Allantoma*, all genera of the Lecythidaceæ.

Huber (4) estimates the number of woody species in the Amazonian basin at 10,000. Three-fourths of these, he states, are woody vines and small trees, leaving 2,500 tree species distributed over an area nearly the size of the United States, exclusive of Alaska. Evidently his small trees would constitute the lower story of the forest that has been described above. If the trees that reach only the height of the second story were excluded, the number would doubtless be greatly reduced. The qualitative analysis of the character of this vast forest region leaves much to be desired from the lumberman's standpoint. If any quantitative analysis of its composition has ever been made I have not seen it. For reasons stated above, I believe that for the whole region not more than 300 species would constitute the bulk of the timber, and most of these would have woods so similar in character that they would be mixed when placed on the market. For any given area that a lumberman would want to log, not more than ten species would be found to yield at least 80 or 90 per cent of the lumber. Although the above examples of the character of the composition of the forests do not break down the contention that tropical forests are very complex from the botanist's standpoint, yet they do destroy the persistent myth that they are complex from a forester's or lumberman's standpoint. In fact, in some instances they approach closely the best deciduous forests of temperate regions in simplicity of composition, and over large areas could be made, and in some instances are being made, to yield larger amounts of hardwoods per acre than do our own virgin stands of hardwood forests.

The statement that the valuable woods of tropical forests "occur in single individuals scattered among hundreds of other species, so that to supply any considerable quantity of any one kind requires culling over many acres, which renders them too expensive for general use," has been repeated in many different ways. This statement is based not on what the forests contain, but on what is found in the markets, especially of Europe and the United States, and to a less extent the tropical markets. True mahogany (*Swietenia* spp.) is the best-known tropical wood in the United States markets, and indeed is very scattered in the forests, yet to judge the character and amount of the wood in the forests from mahogany alone is surely erroneous. Cedro, or Spanish cedar (*Cedrela* spp.), is another valuable wood of tropical America that is well known in our markets. This wood is a very common one in the larger markets of South America, and especially in southern Brazil and Argentina. Here, in spite of the fact that it is a higher-priced timber, it is employed for many of the same classes of construction work that the imported conifers are. Cedro cannot be considered a common tree in the forest, although, comparatively speaking, it is very common in the markets. In the so-called teak forests that I saw in Burma there was less than one mature teak tree to the acre. The volume of the dipterocarp woods in this forest constituted more than one-half of its total volume. Yet the forest was managed principally for teak, and with one exception, pyingado (*Xylia dolabriformis*), the other woods were seldom utilized. When I first went to the Philippines one seldom heard of the dipterocarp timbers, although they were on the market. The hue and cry of the lumberman was for the concessions containing hard, durable timbers, especially those with beauty in color and grain, yet when I visited the forests I was surprised to find that these timbers were as scarce as gold nuggets in a mining region with large quantities of low-grade ore deposits.

What is the meaning of this search for gold-nugget woods in a forest that is rich in great quantities of ore-deposit timbers of a low grade? There are several conditions that have to be taken into consideration. In the first place, the wood-destroying forces in the tropics are much greater than in temperate regions. The continual heat and moisture favor the rapid development of fungi, and with the presence of wood-destroying white ants (termites) tend to shorten the life of non-durable timbers; consequently hard, durable timbers are sought for permanent structure, or else materials like rock, brick, and cement are used.

In tropical countries that are little developed commercially the cost of extracting such timbers by crude methods (animal and manual labor) is great, but the ruling prices justify the expense. The cost of extracting the non-durable timbers by the same methods is as great, or, in the case of the lighter woods, nearly as great. The price paid for such timbers is comparatively low, so that the profits, if any, are much lower. Again, the demand for cheap construction timbers is supplied by bamboo stems or palms and small or young poles, or, in the case of the scarcity of bamboo, adobe is used extensively as a cheap building material.

In consequence of all this very little lumber is used for general construction purposes. In the Philippines, where lumber is used for construction of houses more than in any other tropical country that has come to my notice, only the well-to-do people can afford to build their homes of lumber, the poor living in bamboo huts. In most South

American countries, with the exception of the interiors, very little lumber is used in the construction of buildings of any kind.

What happens when a tropical country awakens from its business lethargy and begins to develop its natural resources? In the first place, it finds itself without sufficient lumber products of all kinds, especially cheaper general construction timbers, to meet the demands. Take the Philippine Islands, for example. With the introduction of a stable government the development of the country proceeded at a rapid pace. Construction work of all sorts began without sufficient lumber to supply it. This demand was met by importations of Oregon pine (Douglas fir) from the United States. Exploration work showed that the forests contained light construction hardwoods in enormous amounts mixed with less amounts of heavier but non-durable timbers for heavier construction work and heavy durable timbers for construction work where contact with the ground was necessary. Moreover, the forests were found to be in heavy stands. These three classes of timber, known respectively as lauans, apitongs, and yacals, were found to be good substitutes for all classes of construction work for which Oregon pine was used. For a few classes of work they were poorer substitutes, but still could be used, and for many they were better. The Philippine Government, recognizing the conditions, encouraged the lumbermen by granting large concessions for a period of 20 years to enable them to raise sufficient capital for the introduction of modern milling and logging machinery and to build logging railroads. The difficulties of these pioneer lumbermen read like a romance. Starting with little capital, and in some instances with little or no knowledge of logging, they had to overcome great odds. Many of them failed. Others, by persistent efforts, solved the problems of getting labor and of teaching it to handle machinery. Then, too, there were difficulties of sawing new kinds of woods and transportation of the lumber to the markets. Many of the mills when installed were found not to have sufficient horsepower to handle the timbers, and such had to be replaced. In one instance locomotives and light steel rails from an old railway had to be replaced with a better equipment. These and other difficulties were surmounted. In the meantime native lumber began to come on the market in larger quantities. Many American contractors refused at first to handle it because they were not accustomed to it. Small Chinese contractors who had been used to whipsawn boards half an inch or less in thickness were reluctant to accept lumber an inch thick that was sized, trimmed, and edged. The prejudices of the East and the West had to be broken down. In the lumbermen's campaign to accomplish this, great aid was rendered by the Philippine Government, when it specified that for all its construction work native timbers should be used. As the largest consumer of timber was the Government, this action reduced the use of imported timbers to a minimum. By the time the world war broke out the Philippines were not only in a position to supply all their own timbers, but in 1916 furnished more lumber for export than they had previously imported in any one year. The Chinese market absorbed the bulk of this exported lumber. While the lumber industry is comparatively small, it has great possibilities. I have cited the Philippines as an example because here is the only country where modern logging and milling methods have been introduced on a comparatively large scale to utilize the so-called weed-trees of tropical hardwood forests. What has been done in the Philippines is possible in many parts of the tropical world. Enterprising lumbermen can overcome the difficulties now in the way of developing tropical forests on a large scale.

Let us take a survey of some of the tropical forest regions of the world and see what the possibilities are. One of the most active industrial tropical and semi-tropical regions in the world is southern Brazil. According to a report of the Brazilian Government (5), the forested area of this region of Brazil is estimated at 1,058,000 square kilometers (approximately 260 million acres). There are two fairly distinct forested regions—the coastal and plateau. The former has a high annual precipitation and, for the most part, a high temperature. In no place is it far distant from tide water. It is heavily forested. Unfortunately there are no estimates of the total amount of timber. H. M. Curran has examined a large timber property in the mountains back of Bahia and finds the forest has an average stand of about 10,000 board feet per acre; according to the types, the stand will vary from 6,000 to 13,000 feet per acre. About 10 species will furnish the bulk of the cut. He estimates that comprising 42 per cent of the cut are soft hardwoods similar to yellow poplar. Thirty per cent are similar to maple and ash in hardness and 28 per cent harder than white oak. The softer species are little known on the markets, but could be introduced and substituted for the uses for which imported pine is employed.

The plateau district lying behind the coastal mountain ranges has a lower temperature and rainfall. In places it is fairly heavily forested with hardwoods and Paraná pine (*Araucaria braziliensis*). The hardwoods are usually confined to the valleys, though patches of them are found on the uplands. The botanical distribution of the Paraná pine is from 20° south to 30° south latitude. It is confined to the uplands and is commercially abundant in the States of Paraná, Santa Catharina, and parts of Sao Paulo and Rio Grande do Sul. Simmons (6) states that in Paraná one company claims ownership of connected forest tracts of Paraná pine, a large part of which is in a primitive state, aggregating three billion feet and averaging about 4,000 feet to the acre. There are sections where the growth is thick and large; the stand scales as high as 15,000 to 20,000 feet to the acre.

The above are the only available figures that give any indication of the volume of the forests. Assuming that the estimate of an area of 260 million acres for the region under consideration is correct, divide this area by two to make a liberal allowance for non-merchantable forests, clearings, etc.; there will remain 130 million acres covered with merchantable forests. At 5,000 board feet per acre this will give a total of 650 billion feet. It is believed that this estimate is very conservative. At any rate, for all practical purposes it is sufficiently accurate.

There is nearly twice as much standing timber in this region as in the southern yellow-pine forests of the United States (8), the most active lumber-producing center in the world, with an annual cut of 15 billion feet. According to Simmons (6), the annual cut in Brazil is but 101 million feet, which, together with 64 million feet of imported lumber (mostly southern yellow pine), makes a total annual market supply of 165 million feet. When the industrial awakening came to southern Brazil, it found itself in exactly the same position as the Philippine Islands—a large amount of timber, but a lumber industry insufficient to cope with the increased demand; consequently nearly 40 per cent of the lumber used was imported.

Of late years the lumber industry has begun to develop, especially in the Paraná pine region, where logging machinery has been introduced and the increased cut of native pine is gradually reducing the imports. So far little, if any, effort has been made to introduce modern logging methods in the hardwood forests of the coastal region.

The resources of the Paraná pine forest are limited, probably not constituting more than one-tenth the total stand of southern Brazil, and the country in the far-distant future will have to depend more and more on its hardwood forests for light construction timbers, unless it continues to import them. Already there are a number of groups of light construction native hardwoods on the markets that are used extensively for the same purposes as the native and imported pines. These are the cedros (*Cedrela* spp.), the perobas (*Aspidosperma* spp.), the canellas (species of the Lauraceæ), the louros (*Cordia* spp.), and many others. With the introduction of better logging methods, the still lighter hardwoods can be logged at a cost that will yield a profit, whereas now with the crude methods such is not possible.

War conditions have probably reduced or cut off entirely the importation of lumber to Brazil. This is probably stimulating the lumber industry to greater efforts, or else the amount of lumber that is consumed is greatly reduced. If the war conditions should continue long, the lumber industry would undoubtedly be greatly stimulated. After the war, when the lumber industry of the United States will be pushed to the limit to furnish timber for the increased demand at home and to the Allies in Europe, the amounts that reach southern South America may be limited and possibly cut off entirely by the United States Government.

The amount of imported timber consumed annually in Brazil, Argentina, Uruguay, Chile, and Peru approximates 600 million feet; for Brazil and Argentina, mostly southern yellow pine; for Chile and Peru, Douglas fir, as against 257 million feet of South American woods (6, 7). This is mostly sawn lumber. No estimate is available for the consumption of native wood in all its forms, such as railroad ties, paving blocks, firewood, telegraph and telephone poles, etc. I should not be surprised that, if the figures were available, the total amount of native woods consumed would reach nearly to one billion board feet. The amount of firewood alone used must be great, for many railroads, sugar mills, etc., use wood for fuel. Practically all native woods are used for railroad ties in both Brazil and Argentina. In the latter country the government specifies the use of native woods for railway sleepers. Argentina and Uruguay alone import 450 million feet from the United States and Europe, as against 119 million feet of South American woods. Of this amount 63 million comes mostly from Brazil and Paraguay and 56 million mostly from the Gran Chaco region of northern Argentina.

To sum up, the stand of timber in the southern Brazil region and adjacent regions of Paraguay and northern Argentina is sufficient to supply the entire market of southern South America. Will the lumber industry in this part of the world be sufficiently developed to meet the necessity that confronts it?

Turning now from the western tropics to the eastern tropics, let us see what the situation is. I have already traced the development of the lumber industry of the Philippines from an importing to an exporting country. I have shown that the major part of the timber in its forests consists of hardwoods that have locally replaced pine for all sorts of construction work; that the main bulk of the timber in these forests consists of members of one family (9, 10), and that modern logging methods introduced into these forests have made it possible to employ timbers that were formerly little used. I have called attention to the fact that the same class of forests extends throughout practically the whole of the Malay region, including parts of Burma. My estimate is that the virgin dipterocarp forests of the Philippines, Borneo, Sumatra, Malay Peninsula, Burma, and Cochin China cover an area of no less than 320 million acres. Again, to be conservative, cut the area down one-half, to 160 million acres, and taking an average of 10,000 feet to the acre, we have a total of 1,600 billion feet of standing timber. In amount this is about equal to the standing timber in the Pacific Northwest (Washington, Oregon, Idaho, Montana, and British Columbia), which produces annually about 8 billion board feet.

The Malay region is geographically nearer to the importing countries of Asia and the South Pacific (Australia and New Zealand) than is the Pacific Northwest, yet the latter has furnished to China and Australia an annual supply of over 300 million feet. What are the possibilities of the former region meeting this demand?

Even in the Philippines, where the lumber industry is best developed, with a maximum cut of 145 million feet (11), it is only in its infancy. The Philippines alone, with a stand of timber of 200 billion feet, could increase their cut to one billion feet without endangering the forest capital. The impetus given to the lumbering in the Philippines has already spread to British North Borneo, where American foresters are now in control, and to the Dutch possessions of Borneo, Java, and Sumatra. It remains to be seen whether or not the conservatism of the British in the Federated Malay States and Burma regarding their practically untouched dipterocarp forests can be overcome.

Turning again to South America, we find the largest continuous forested region in the basin of the Amazon River. This forest, comprising northern Brazil and portions of the republics of Colombia, Ecuador, Bolivia, and Peru, is estimated to cover not less than 1,024 million acres. Reducing the area one-third and estimating the remainder, 683 million acres, at the very low figure of 5,000 feet per acre, we have a total stand of about 3,400 billion feet of timber. In the United States the forested area is estimated at 550 million acres, carrying a stand of 2,800 billion feet, or about 5,000 feet per acre.

The Amazon forest can be regarded as the greatest reserve forest of the world. While it is not as near to lumber-consuming centers as the other forest regions that have been mentioned, water transportation alone considered, it is nearer to the great centers of the eastern United States and western Europe than the Pacific Northwest. Aside from climatic conditions, there is no other forest region that has its physical conditions so well adapted to lumbering. There are literally thousands of miles of navigable rivers and many more thousands that are drivable. Ocean steamers ply up to rivers over 2,500 miles from the coast. Moreover, little of the area is over 1,000 feet in altitude. The climatic conditions are not so bad as non-dwellers of the tropics make them out to be. Besides Pará, a city of 200,000 people, at the mouth of the Amazon, there are Manaos, a city of 80,000 people, nearly 1,000 miles inland, and Iquitos, Peru, with about 20,000 inhabitants, about 2,500 miles inland. These cities now all have modern sanitary conditions and are otherwise modern. Yellow fever is practically a thing of the past. So far, a single forest product, rubber, has been the principal source of revenue for the region. Next to coffee it leads all others in the value of the exports of Brazil. The lumber industry is practically undeveloped. Only a small amount of lumber for local use and export is cut and some is imported.

Due to competition of planted rubber from the eastern tropics, the production of rubber of late years has not increased, though it has not diminished. The Brazilian Government realizes the situation and is encouraging the agricultural possibilities. The region at present depends almost entirely on outside produce to keep the rubber industry going. The development of the lumber industry will be slower than that of southern Brazil, mainly because labor is scarce. However, as this industry develops in the settled part of the country it cannot but help give a decided impetus to that of the Amazon region.

There remains to be discussed another forest region in South America of great extent, namely, northern South America. It comprises the Guianas, Venezuela, and that portion of Colombia that does not lie east of the base of the Andes. Rough estimates show that this region includes no less than 200 million acres. Cut this area one-half, to 100 million acres, and using the conservative figure of 5,000 board feet per acre, we have a stand of 500 billion board feet. The republics of Colombia and Venezuela, that contain the largest part of the timber, are still very backward in development, both commercially and politically; hence their lumber industry is little developed. Crude methods of logging still prevail; yet some of the forests, especially parts of the Magdalena, Cauca, and Atrato valleys, contain heavy stands of timber and are adapted to modern logging methods. Geographically this region is well situated to supply timbers to Panama and the West Indies, which at present draw on the United States for large quantities of timber. So far as the forests are concerned, they contain timbers that could be employed for many uses in the United States.

With the possible exception of the tropical forests of Central America, including southern Mexico, and those of Africa. I have outlined above the largest virgin forest regions of the tropics. I have purposely omitted India proper, for the areas of virgin forests in India are comparatively small. Those of Burma, which contain the largest virgin or nearly virgin areas in British India, have been included in the dipterocarp region.

I think all estimates given above, even that of the United States, are under, rather than over, the actual amount of standing timber. When availability is concerned, there is no doubt that, because of transportation facilities and for the reason that the lumber industry is incomparably better developed than in any of the other regions discussed, the United States will continue to furnish even larger supplies than it is doing now.

But what effect will such a drive at production have on the future supplies of home-grown timber in the United States? The greatest producing center today is in the southern yellow-pine region. It is already greatly overcutting its annual increment. Yesterday it was in the white-pine region of the Great Lakes, northeastern part of the United States, and adjacent parts of Canada. This region is being combed now of its remaining stands of the original capital. Tomorrow it will shift to the Pacific Northwest, where the cut is already approaching the annual increment and where the available stands are yearly getting farther and farther from tide water. It will only too soon reach and pass its annual increment, and then our last existing forest capital will be drawn upon. Day after tomorrow we will still be called upon to furnish immense quantities of timber (1) to rehabilitate our now lagging wood-using, non-war industries, and many war industries (such as railroads) (2) to furnish supplies to our Allies in Europe and (3) to furnish supplies to the rest of the world. There is no doubt that, unrestricted, our lumber industry could meet the situation, but at great cost to our forest capital, and especially that part of it in the Eastern United States, the portion that is of greaest value to us. Far-sighted men are already suggesting the advisability of a post-war restriction on exporting lumber. It is estimated that in normal times not over 10 per cent of our cut is exported. This amounts to approximately four billion feet. As stated above, the amount that goes from North America and Europe to tropical countries, China, and south temperate countries is approximately two billion feet, of which probably more than one and a half billion feet is from the United States. Such a restriction, if it is not brought about by government action, may come by lack of transportation. The effect would be to stimulate the production of lumber in the tropics as it has already been stimulated in certain parts of the Malay region and probably in some of the other regions mentioned in this article.

What effect would such a stimulation have on the exports of lumber from these countries to North America and Europe? In spite of the fact that the largest percentage of the timbers in tropical forests are non-durable hardwoods that can be classified as soft hardwoods, or those medium in hardness, some of these have beautiful color and grain, that make them good woods for many classes of construction work, such as interior finish, and are good substitutes for mahogany. Referring again to the Philippines, we have an example in the lauans, which can be divided into white lauans and red lauans. The red lauans (including tanguile) have the color and grain of mahogany. A certain per cent of the finest grades of these lauans command higher prices and some are exported. In 1916, in spite of the difficulties of transportation, six million feet were exported to the United States, being sold under the names of tanguile mahogany and Bataan mahogany. The new demand for true mahogany, used for airplane propellers, will draw heavily on the diminishing available supplies of this timber in southern Mexico and in Central America. There are many other tropical woods that could be used as a substitute for it.

After the war the amount of railroad sleepers that will be required to repair our railroads and those of Europe will be enormous. A certain percentage of practically all tropical forests contain hard, durable timbers that are little known outside of the local markets. The railroads of Brazil, Argentina, and the Philippines are built of them. Some of our own railways are making tests of some of these ties from the Amazon region. Many of these woods last from 15 to 20 years and more in the severe conditions of the tropics, where decay goes on much more rapidly than here. In temperate climates they would have a much greater duration than creosoted ties that are being extensively used. The first cost of using such woods might be great, but it would be economy in the long run. Tropical forests also contain valuable woods other than teak that could be substituted for this wood and temperate woods for shipbuilding, especially for those parts that require hard, heavy timbers to withstand the wear and tear. In fact, there is scarcely any end to the uses to which tropical woods of all kinds could be employed in temperate regions. In many cases they would fit the situation better than those now used. In others they would be good substitutes. The development of the lumber industry in the tropical regions would, no doubt, lead eventually to the introduction of many of these woods into our markets.

SUMMARY

1. The following table gives a rough estimate of the forested areas and amount of timber in the tropical regions discussed in this article. The estimates of the United States are included for the sake of comparison:

TABLE 1.—*Area and Stand of Forested Regions*

Forest region	Forested area in million acres	Stand of timber in billion board feet
Southern Brazil	260	650
Amazon basin	1,024	3,400
Northern South America	200	500
Malay region	320	1,600
Total	1,804	6,150
United States	550	2,800

2. Contrary to the common belief, tropical forests contain all classes of construction timbers which could be used to replace the woods that are now principally obtained from temperate regions.

3. No less than 2 billion feet of mainly coniferous woods are shipped annually from temperate North America and Europe to tropical countries and those like Argentina, China, Australia, and New Zealand, which are, with one exception, geographically located much nearer to tropical forested regions that carry heavy stands of timber than they are to Europe and North America.

4. Because of the lack of transportation, these markets are practically cut off from the supplies of coniferous woods that they formerly obtained. This condition will undoubtedly continue for the duration of the war, and, because of increased needs at home, probably for some time after the war.

5. Such a condition is now stimulating the lumber production in some tropical regions, and if the war and post-war conditions described above continue long enough they will become practically independent of foreign supplies and will be furnishing their next-door neighbors, who are less fortunate than themselves in having large forested regions.

6. The forest region of southern Brazil is advantageously situated to supply the demands of all of southern South America.

7. The dipterocarp region of Malaysia and Burma is in a geographical position to supply China, India proper, and the whole South Pacific region.

8. The northern South American region could be made to supply the demands of the West Indies, Panama, and other near-by regions.

9. The Amazon region, the greatest forested area in the world and the least developed commercially, is likely to lag behind the others because of no near market.

10. If the lumber industry of these regions is stimulated, our own markets and those of Europe will draw on them more and more for certain classes of construction timbers.

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THE ABSOLUTE FORM QUOTIENT[1]

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The stem forms of Norway spruce and Scotch pine have been very thoroughly studied by Mr. Tor Jonson, forest engineer and professor in mensuration and forest mathematics at the Royal Forestry College, Stockholm. Some very interesting conclusions have been reached and volume taper and growth per cent tables, based on the results of the investigations, have been constructed and adopted for use by the Swedish Forest Service.

These conclusions are:

(1) The taper of the stem follows a law which, broadly speaking, is independent of age, d. b. h., height, and also of site.

(2) As an expression for taper a mathematical equation, giving the relation to each other of the diameters in different portions of the stem, may be used to great advantage.

(3) The degree of taper differs considerably, however, and a characteristic expression thereof can be obtained by comparing the diameter at breast height with the diameter at a point situated half way between breast height and the top of the tree. This "upper diameter" is divided into the diameter at breast height, and the quotient, called the "absolute form quotient," expresses the "form class" of the tree.

(4) With the knowledge of form class, total length, and diameter at breast height, all other dimensions may be accurately determined.

(5) There is no essential difference in form between the Scotch pine and spruce *inside bark*. The bark, if added, however, gives the pine a poorer form and lower form quotient. In spite of this difference in form, however, the cubic contents (bark included) of spruce and Scotch pine with the same d. b. h., total height, and form quotients are found to be practically the same.

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[1] This article is based upon the following: *Taxatoriska undersökningar öfver skogsträdens form*, by Tor Jonson; I. *Granens stam-form*, Skogsvårdsföreningens Tidskrift, 1910, No. 11; II. *Tallens stam-form*, Skogsvårdsföreningens Tidskrift, 1911, No. 9-10; and III. *Formbestämning å stående träd*, Skogsvardsföreningens Tidskrift, 1912, No. 4.

Most of the information contained in the article and cognate matter having reference to form quotients has been briefed in *Forestry Quarterly* (see Vol. I, 56; V, 29; XI, 399) and in the Journal (Vol. XV, p. 665), but it was deemed desirable to give a fuller and more connected account of the later development of the important subject.

The spruce (*Picea excelsa*) was first studied. Jonson's first object was to find a good *system of classification.*

Trees of the same diameter and height may vary considerably in volume content, owing to different taper. To express this variation in form the *form factors* had been devised. The form factors, however, are troublesome to arrive at, as they cannot be measured directly, it being necessary first to compute the volumes of the tree carefully.

The breast height form factor, hitherto in use, changes not only with the form of the stem, but also with the height, and it is therefore not a suitable expression of form, for the basal area of the cylinder is taken at a proportionally greater height on a shorter tree. Therefore the cylinder is smaller the shorter the tree is, and consequently, with an increase of height, the form factor of trees of the same form is reduced.

The Rinicker form factor, which is used to compare the portion of the stem above breast height with a cylinder having a diameter equal to the d. b. h. and a height equal to the height of the tree above breast height, is a correct expression of form, but has not been used to any great extent.

The form quotient, first devised by Schiffel, is an excellent expression of stem form, however, and it is also very convenient, as it is easily determined.

The form quotient, according to Schiffel, is expressed algebraically: $q = \frac{d}{D}$, d being the diameter at the middle of the stem, D the diameter at breast height, and q the form quotient.

Professor Jonson does not, however, accept this formula unchanged, for in this, as with breast height form factors, the classification is made dependent on height, the two form-determining diameters not being in the same relation to each other in trees of different height. For instance: In classifying two conical trees, 10 and 30 meters high above stump, the diameter at the middle height of the tree will be compared with d. b. h. at one-tenth of the height of the short tree and with the d. b. h. at one-thirtieth of the height of the taller tree. This gives the 10 m. tree form quotient 0.56 and the 30 m. tree form quotient 0.52. This, though both trees have the same (conical) stem form. On a tree 2.6 meters high both measurements will be taken at 1.3 m., which gives $q = 1$, or cylindrical form, while the tree may really have any form at all without the form quotient being changed. Consequently, trees of different heights must have different form to get into the same "form class," which, of course, is illogical. This and other inconsistencies disappear almost entirely, Jonson considers, if the "upper diameter" *is measured at the middle of the portion of the stem lying above breast height.* This form quotient, which Jonson calls the *"absolute form quotient,"* is used to classify the trees examined in regard to taper or form. According as the diameter at the middle of the stem above breast height is 55, 60, 65, 70, 75, or 80 per cent of the diameter at breast height, form quotient classes, or *form classes,* 0.55, 0.60, 0.65, 0.70, 0.75, or 0.80, are obtained.

The taper tables for spruce published by Jonson were obtained from other tables by analytical geometric calculations. He also examined sample trees, partly to investigate the variation in form in individual trees and partly to prove the applicability of the mathematical calculations for practical purposes.

Investigations in Norway Spruce (Picea excelsa)

A number of normal spruces of different diameters and heights were chosen as sample trees. These were classified according to their absolute form quotients in form classes 0.60, 0.70, and 0.80. The portion of the stem above breast height was divided into 10 sections of equal length and the top diameter of each section was measured. *The measurements were thus taken at proportionally the same height on all trees*—that is, in addition to breast height (1.3 meters), at one-tenth, two-tenths, three-tenths, or 10, 20, 30 per cent of the stem above breast height. The ratio between each measured diameter and the d. b. h. was then ascertained.

In addition an eleventh measurement was taken 0.3 meter from the ground. All diameters were measured *with bark,* as it has been proven that *the bark of spruce practically is proportionate to the diameter at any point along the stem.*

Maass (Sweden), Schiffel (Austria), and others have shown that trees with the same form quotient and of equal height taper according to a fixed law. For instance, if two trees 20 meters high, but of different d. b. h., have "upper diameters" which are 70 per cent of d. b. h.—that is, belong to form class 0.70—the diameters at 5, 6, 7, 8, etc., meters constitute the same percentage of the breast-height diameter on both trees. The absolute taper is, of course, not the same.

Professor Jonson reaches the conclusion that taper of trees of the same form class is also independent of height, the measurements being taken at proportional places—for instance, at each tenth of the stem above breast height.

The table exhibiting the result of these measurements shows the variations very small. Normal trees belonging to other form classes were also examined, and the variations between individuals or groups of individuals in the same form class were found so insignificant that Professor Jonson considers himself justified in stating: "The percentic taper is the same in all 'normal' spruce of the same form class, notwithstanding differences in height and diameter. A large tree is constructed exactly as a small tree, providing both have the same absolute form quotient."

EQUATION OF THE STEM CURVE

After having shown the similarity in stem form of normal spruce within the same form class, Jonson's next step was to find a mathematical expression therefor.

Many foresters (Breymann, Metzger, Pressler, Strzelecki, Nossek, Phillipp, and others) have constructed formulas to serve as mathematical expressions for all forms of tree-stems. They have all been criticised by Schiffel (Austria), who stated that none of them had been able to construct an equation for stem taper which is really consistent with nature.

A. G. Hoejer, a Swedish civil engineer, has published the following formula as an expression for stem curve: $\frac{d}{D} = C \log \frac{c + l}{c}$, where D = diameter at the base, d = diameter at a distance l from the top; C and c are constants.

Jonson generalizes this formula and uses it to calculate the taper for each form class. If, for example, it is desired to compute the taper series for form class 0.70, diameter d, measured half way (= 50) between top and d. b. h., is 70 per cent of the diameter at breast height, D, which is regarded as base (= 100) and situated a distance of 100 from the top.

By inserting these known values in Hoejer's equation, we obtain:

$$\frac{70}{100} = C \log \frac{c + 50}{c} \qquad (1)$$

and

$$\frac{100}{100} = C \log \frac{c + 100}{c} \qquad (2)$$

If equation (2) is divided into equation (1), we find: $0.70 \log (c + 100) = \log (c + 50) + (0.70 - l) \log c$. By trying out different values for c, Professor Jonson finds $c = 19.78$. By inserting this value for c in equation (2) we get $\frac{100}{100} = C \log \frac{19.78 + 100}{19.78}$ and $C = 1.28$.

Inserting the values for C, c, and D in Hoejer's formula, it becomes possible to calculate the diameter d at any height within form class 0.70.

Having found the constants for each form class, Jonson uses the formula to compute the diameter at each tenth of the stem above d. b. h.—that is, the values of l are 10, 20, 30, etc.—the top being equal to 0 and d. b. h. equals 100. The diameters are thus computed at the same points as on the analyzed sample trees.

Table I gives the constants and taper series for six form classes, and figure 1 shows the series of values given in Table I, represented graphically.

Table II is a comparison between mathematically computed diameters and absolute form factors and diameters and form factors obtained from measurements on sample trees. As will be noted, the differences in form classes 0.60 and 0.70 are very small. Form class 0.80, however, shows a somewhat greater variation. This is probably to a certain extent due to the small number of examined trees, but more, no doubt, to the fact that 0.80 is a "border" class, where "regular" trees are comparatively rare. It is probable, however, that if a larger number of test trees had been examined the result would have been much better in this form class.

Since Professor Jonson published the figures given in Table II he has had opportunity to examine an additional number of sample trees, and has reached the conclusion that the *mathematical formula shows complete conformity with nature when applied to spruce* of all form classes.

Divergencies from the "Normal Form" of Spruce

Individual trees will, of course, sometimes show a divergency from the "normal form." For instance, large nodes or damage to the stem near the place of measurement may upset the series. The effect of irregularities of this kind, however, is generally adjusted if a sufficient number of trees are measured.

In regard to systematic divergencies which do not disappear from an average series, whatever the number of examined trees may be, Jonson states that in some stands, which had been grown from imported seed, it appears as if the measurements in the upper sections fall one or two per cent short. Those stands were composed, however, of relatively young trees, growing rapidly in height, and one explanation is that they had not yet had time to "fill out."

It is also probable that suppressed trees, which suddenly become more or less isolated through removal cuttings or thinnings, will sometimes for a short period show a divergency from the normal form *in* *the upper sections.* Jonson considers the systematic nature of these divergencies as somewhat problematic, however.

Root swelling, if reaching above breast height, will, of course, cause a divergency between the measured and mathematically computed stem curves. It occurs to a more or less degree in all spruce, but has no influence on the stem-curve calculations unless it reaches above breast height, in which case it was considered by Jonson an abnormality.

Of the test trees examined, Jonson found that 10 per cent had root swelling reaching above d. b. h. These trees were consequently excluded.

The simplest practical way to avoid the incorrect results due to high root swelling is to measure the d. b. h. just above the swelling—that is, at the turning point between the more or less concave curve above the swelling and the convex curve in the lower portion of the tree.

VOLUME CONTENT AND FORM FACTORS

The form of the stem in all portions being known, there will be no difficulty in computing taper tables, volume content, and form factors.

Tables of taper for spruce were constructed. These tables, based on the formula for the stem curve, give the diameter in per cent of d. b. h. at every meter counted from the stump. The height of stump is taken as 1 per cent of the total height of the tree.

To obtain the absolute or Rinicker form factor for the volume above breast height, Jonson first computed the volume in each form class with the known diameters as basis.

For instance, the stem above breast height is divided into ten sections of equal length as before. The diameters are $D, d_1, d_2, d_3, \ldots d_9$, and the corresponding basal areas $B, b_1, b_2, b_3, \ldots b_9$; the length of each section is $\frac{L}{10}$, and the volumes of the sections $V, v_1, v_2, v_3, \ldots$ are the product of the average basal area and the length.

The top section is cubed as a paraboloid. Thus: $v_1 = \frac{B + b_1}{2} \frac{L}{10}$; $v_2 = \frac{b_1 + b_2}{2} \frac{L}{10} \ldots ; v_{10} = \frac{b_9}{2} \frac{L}{10}$ and the volume above d. b. h. $V = v_1 + v_2 + v_3 + \ldots v_{10}$; and the form factor $\frac{V}{BL} = \frac{L\left(\frac{B}{2} + b_1 + b_2 + \ldots b_9\right)}{10.\,B\,L}$, or by canceling L and $\frac{\pi}{4}$ the absolute (Rinicker) form factor $= \frac{\frac{D^2}{2} + d_1^2 + d_2^2 + d_3^2 + \ldots d_9^2}{10.\,D^2}$.

Putting as before the d. b. h. = 100, the values of d_1, d_2, d_3, etc., are found in Table I and inserted in the above formula. The Rinicker or absolute form factors for the form classes are then computed. See Table I.

The form factors do not form an arithmetical series as the form quotients, but increase more rapidly, so that the form factor in each subsequent class is about 10 per cent larger than in the preceding one.

When constructing the volume tables for pine and spruce Professor Jonson uses the *breast height form factor.* In doing this he reduces the form factor by a method which differs somewhat from the usual one.

Just as the volume of the stem above breast height is the product of the basal area at breast height, length of stem above breast height and an absolute form factor, so we obtain the total volume of the tree by multiplying the basal area at the stump with the total height and a suitable absolute form factor f_0.

The correct basal area at stump cannot be directly measured on account of the root swelling. We obtain this area, however, by calculating how many per cent the normal stump diameter D_0 is larger than diameter at breast height D. This computation is made with the help of the equation for the stem curve.

If we obtain $D_0 = 1.0p\ D$, then $D_0{}^2 = 1.0p^2\ D^2$ and

$$B_0 = \frac{\pi D_0^2}{4} = \frac{\pi D^2}{4} \cdot 1.0p^2 = 1.0p^2\ B.$$

The normal stump diameter D_0 being known, the absolute form factor for the volume on stump is easily obtained by interpolation in Table I, if we know the new form quotient of the tree. If, for example, the diameter halfway between stump and top is found, with the help of Hoejer's formula, to be 67.7 per cent of d. b. h. and D_0 is 103.0 per cent, then the new form quotient is $\frac{67.7}{103.0} = 0.657$ and the absolute form factor, f_0, by interpolation = 0.449.

The total volume of the stem is $V = B_0 .\ h .\ f_0$ or $V = B.\ 1.0p^2\ h .\ f_0$. the breast-height form factor $F = \frac{V}{B\ h} = 1.0p_2\ f_0$.

A sufficient number of breast-height form factors were computed in each form class and then multiplied with their respective heights. The "form heights" obtained were then plotted graphically with the heights as the abscissæ (figure 2).

Other not computed form heights and form factors were obtained by interpolation.

Investigations in Scotch Pine (Pinus silvestris)

In his study of the stem form of Scotch pine, Jonson obtained the following results:

As with spruce, a number of normal Scotch pine in different portions of Sweden were selected as test trees. Care was of course taken to exclude any trees which suffered from abnormities or irregularities of any kind.

While for all practical purposes the bark of Norway spruce can be considered proportionate to the diameter at any point on the stem, and consequently the stem form of spruce is the same *over* bark or *inside* bark, this is not the case with Scotch pine. The thickness of bark varies considerably, and the form of the tree with bark is, as a rule, quite different from the form of the same tree inside bark.

It was, therefore, necessary first to ascertain the normal form of the stem exclusive of bark. If to this is added bark of normal thickness a "normal" tree is obtained.

The trees were measured and classified in the same manner as has before been described for spruce, only the diameters were all measured *inside bark*.

After arranging the trees according to form class, it was again found that *trees with the same absolute form quotient were built after a similar model, whether they were short or tall, small or large.*

Following is a comparison between the average series for Scotch pine obtained from actual measurements and the series for Norway spruce of the same absolute form quotient computed by the equation $\frac{d}{D} = C \log \frac{c + l}{c}$

Diam. at section.....	O(b.h.)	I	II	III	IV	V	VI	VII	VIII	IX
Pine, measured inside bark	100	94.5	90.0	85.2	79.4	72.4	64.1	53.9	40.7	22.8
Spruce, computed.....	100	95.6	90.8	85.8	79.4	72.4	64.3	54.7	42.6	26.0
Variation in per cent..	...	—1.1	—0.8	—0.6	±0	....	—0.2	—0.8	—1.9	—3.2

Ave. absolute form factor for pine = 0.502, for spruce = 0.509.

The similarities in stem form between the two species are rather striking. A still better result is obtained if we free the pine series from the effect of a small root swelling. If we plot the series graphically we find that the curve is inclined to go about 1.1 per cent inside the measured d. b. h.

By multiplying all diameter quotients by $\frac{100}{98.9}$ the series is transformed to a series where the d. b. h. has been corrected by 1.1 per cent. We then have the following two series:

Diam. at section	O	I	II	III	IV	V	VI	VII	VIII	IX
Pine, corrected, —1.1 per cent	100	95.6	91.0	86.1	80.2	73.2	64.8	54.5	41.2	23.0
Spruce, computed	100	95.8	91.0	85.9	79.9	73.2	65.2	55.6	43.5	26.8
Variation in per cent of D, —1.1 per cent	...	—0.2	±0	+0.2	+0.3	....	—0.4	—1.1	—2.3	—3.8

The similarity in the lower portion of the stem is now almost perfect.

Jonson now reaches this conclusion that, except perhaps in the upper portions of the stem, *pine inside bark and spruce with or without bark follow the same laws of taper.*

Practically the small divergence in the upper sections is of little or no importance, especially as spruce also sometimes shows an inclination, in the upper parts of the tree, to fall a little short of the values obtained by the formula.

It would, therefore, no doubt be permissible to apply the formula for spruce to pine also. Jonson, however, to obtain still better results, has introduced a new constant, b, in the formula, which then reads: $\frac{d}{D} = C \log \frac{c + l - b}{c}$. He finds that a constant value for $b = 2.5$ seems to bring about a more satisfactory result in all form classes and therefore gives the equation for taper of Scotch pine as $\frac{d}{D} = C \log \frac{c + l - 2.5}{c}$, where C and c vary for every form class.

To discuss the nature of this new constant we will consider $l = 2.5$, when the expression $\log \frac{c + l - 2.5}{c}$ will be written $\log \frac{c + 2.5 - 2.5}{c} = \log \frac{c}{c} = \log 1 = 0$. Thus we have, according to the new formula, $d = 0$ at a distance of 2.5 per cent from the top.

Consequently the new constant, b, must signify the same quantity as l or per cent of the portion of stem above breast height, and, in addition, the effect of a value $b = 2.5$ will be that every diameter will be computed as if it lay 2.5 per cent higher up on the stem, by which smaller diameter values will be obtained, specially in the top and in the best form classes, where the taper in the uppermost sections is very rapid.

New values for the constants C and c are computed for each form class as for spruce.

The new constants, the corresponding taper series, and absolute form factors are given in Table III.

If we compare these series with those for spruce given in Table I, we will find that the difference is very small. The difference lies principally in the top diameters and is therefore of little or no importance for practical purposes. For form class 0.70 the two series are:

Spruce	100	95.2	89.9	84.0	77.5	70.0	61.4	51.3	38.3	22.7
Pine	100	95.3	90.0	84.1	77.5	70.0	61.1	50.6	37.2	19.4
Difference in per cent...	...	0.1	0.1	0.1	0	....	0.3	0.7	1.6	3.5

Table IV gives a comparison between the measured and mathematically computed diameters and the absolute form factors.

Tables of Taper

Similar as for spruce, tables of taper have been constructed for pine inside bark.

The difference in the values given in the two tables is very small. however, and in the book of tables adopted for use by the Swedish Forest Service the table based on the formula for the stem form of Scotch pine is included under the following title: "Taper table for *Scotch pine and spruce* inside bark. The table is also applicable to spruce and other thin-barked species (not Scotch pine) outside bark."

Since measurements on standing trees are taken outside bark, it was necessary to study the thickness of bark of Scotch pine in different portions of the stem, and especially at breast height. Jonson examined some 4,000 trees in regard to this.

Other very important developments are Jonson's method of determining the form class of standing trees and the construction and use of his taper and volume tables. Jonson's method of determining form class (the table referred to in this description is the volume table published by Professor Jonson) is as follows:

The position and form of the crown is a very good indirect measure of the stem form of a tree. According to Metzger, the pressure of the wind on the tree crown constitutes a force which compels the tree to construct its stem in such a manner that the same relative resistance to fracture sets in in all parts, the smallest possible amount of material being used. As the concentrated force of the wind strikes a point situated lower or higher on the tree, we get larger or smaller taper, which means poor or good form class.

With the help of the equation for the stem curve and recognized mechanical laws governing stresses, it has been possible to calculate the normal relation between crown and stem form. As the location of the point of attack of the bending force is determinative of form, this point is called the "form point" and its height is expressed in percentage of the total height of the trees.

When deciding on form class, the point—"the form point" where the wind is considered to exercise its concentrated pressure—is estimated, after which its height in per cent of the total height of the tree is read off with a special instrument. At the foot of each page in the table is given the form point height corresponding to each form class. Those figures are intended for volume measurements inside bark or for trees with bark of practically uniform thickness, such as the Norway spruce. Some species, however, have a bark the relative thickness of which increases toward the root by which the outward form of the tree is impaired.

Below the series of "normal form points" Jonson has given a series of form points which should be used for volume measurements outside bark of thick-barked species, such as the Scotch pine *(Pinus silvestris)*.

When estimating the volume of trees with root swelling reaching above breast height, it is necessary to raise the calipers above the swelling or the estimated volume of the tree will be too high.

When a whole stand or type is estimated and an average form class applicable to all trees is looked for, the following table form class, founded on density, is recommended:

Poor density	0.575–0.625
Fairly good density	0.65
Good density	0.675–0.70
Overcrowded density (pine)	0.70 –0.725
Overcrowded density (spruce)	0.725–0.75

Best results are obtained if the nearest lower form class is used for the dominant trees, as the codominant and intermediate trees have relatively less crown space and therefore better trunk forms than the dominant trees.

The highest and lowest form classes are hardly ever used as averages.

In estimating the content of whole stands one can also reach a fair result by multiplying the breast-height form factor, corresponding to the average form class of the stand, with the estimated average height of the trees and the total sum of the sectional areas at breast height of all trees in the stand.

An experienced estimator working on felled trees or using the "form point method" will before very long have gained experience enough to judge the form class by eye, but he should not omit to check his figures by taking measurements on windfalls or felled trees when opportunity therefor is given.

It is obviously most desirable to investigate the applicability of Jonson's method to American species.

It is not improbable that the formula for the stem curve of Norway spruce will give correct results for our several spruce species and perhaps other thin-barked conifers. Neither is it improbable that a true expression for the stem form of other species may be obtained by inserting a new constant in the general formula, as was done by Jonson for Scotch pine. This constant would probably vary for different species; it will be larger for a species the stem of which dissolves into heavy branches than for a species with lighter branches.

Jonson found that the form classes are, as a rule, fairly constant in a stand and sometimes on whole forests. (Separate taper and volume tables were made for each form class, 12 form classes being used. The lowest is 0.525 and the highest 0.80, the interval between each class being 0.025.)

Objections may perhaps be raised by foresters to the task of securing the diameter inside bark at breast height when analyzing sample trees. This will probably not be necessary in regard to spruce, where all measurements required to determine tree forms may be taken outside bark if desired.

In regard to thick-barked species, it will be necessary in accurate work to make a cross-section at breast height on the test trees. An increment borer may be used, but the portion of the bark in the core will sometimes break and is then difficult to measure.[2]

An intensive study of bark thickness should be carried on, so that the relation between the stem forms with and without bark, and especially at breast height, may be determined.

All measurements should be taken with utmost care and only absolutely normal trees should be selected as sample trees.

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[2] A new increment borer is now made by Beus & Mattson, Sweden. It has a trough-shaped core extractor, permitting the core to be measured before it is removed from the extractor. This instrument is used to great advantage in measuring thickness of bark, according to Swedish foresters.

FRENCH FIR MANAGEMENT IN THE VOSGES[1]

(Translation)

By T. S. Woolsey, Jr.

The various methods of treatment applied to silver-fir stands may take the form of one of the following two systems: (1) Regular high forest; (2) selection high forest. These two systems or methods of management . . . have each their adherents and opponents. . . . Some believe . . . that the regular forest may be more or less remunerative for its owner than the selection forest. . . . Certain purely theoretical reasons seem to prove that the selection forest produces more than the regular forest; but to these reasons numerous examples of regular stands of artificial origin can be opposed that have yielded more than 20 cubic meters per hectare (280 cubic feet per acre) per year. Under these circumstances, as Melard has so accurately said, "Don't make any sacrifices to chance methods, but take the stands as they are and try to make the most of them." The treatment proposed in this study has exactly that aim, of making the best of existing stands without any preconceived idea of regular or selection high forest. The basis upon which the exploitable size is fixed being the money yield, the treatment here presented should apply to fir stands belonging to private owners. Those which belong to the State, communes, or public institutions, by the mere fact of being technically administered, are managed by a great service which has advised (in order to improve these forests) a method conceived under the broadest policy. With this method one can (almost at leisure) work the high forest either as a more or less regular one or else turn it into a selection stand. Concisely, the operations comprised are: General stock-taking over the entire forest; fixing the exploitable size, determining length of rotation, and felling cycle; classification of the growing stock in three

[1] *Le Traitement des Sapirières basé sur la Notion d'Espacement des Tiges.* A. Gazin. Imprimerie Général Lahure, 9 Rue de Fleurus, Paris. 1902.

This little classic was published after having been received favorably by the members of the Société Forestière de Franche-Comté et Belfort in 1901. Gazin is one of the best-known foresters in France. He is a graduate of the National Forest School at Nancy, and reached the rank of inspector (Forest Supervisor) in the Service des Eaux et Forêts, where he rendered distinguished service When the translator met him in 1913 he was forest administrator for the Duke of Penthieve, at Arc-En-Barrois. The translation will give the American profession ideas which may be followed in the United States.

groups—small, average, and large wood. The small wood includes that which is less than a third of the exploitable size and is supposed to be less than a third of the rotation size. The average wood and large wood is from one-third to two-thirds and over two-thirds respectively of the size and rotation age. The forest is considered normal when the large wood is to the average wood as 5 is to 3; finally, the forest being normal, the increment is obtained by dividing the volume of the old wood by a third of the rotation. The probable increment of the old wood up to the time it is cut is added. To be logical, the cut should be secured from the elements which have produced it—that is to say, from the old, small, and average wood, no matter how cut, according to the increment distribution. The forest is divided in two parts: one includes all the compartments which must be run through by improvement fellings, by area on a fixed cycle; the other includes the compartments under regeneration, chiefly old wood, which are cut over according to volume; the balance needed to complete the felling budget is marked annually, after the large wood (cut in the rest of the forest, for any reason whatsoever) has been deducted. The elasticity of this method is evident; it eliminates the period and in consequence the rotation, as far as the utilization is concerned. With it the owner may at his will move as in selection or regular high forest; the latter, however, subordinated to independent outside circumstances (such as steep slope, severity of climate, or extreme slowness of regeneration). If he (the forester) favors the regular high forest, the improvement fellings are made light and the compartments which are thus cut over will have a tendency to form a compact stand—that is to say, to become regular.

The small balance similarly selected will have available (to be cut in the compartments by volume) most of the yield which will permit making heavy fellings, and this would encourage regeneration. If, on the other hand, the owner prefers the selection system, he can with ease make selection fellings throughout the forest. If he (the forester) makes heavy improvement fellings, if he does not hesitate to cull every tree that has reached exploitable size, if he cuts heavily (in selection fellings) in the old wood, marking without hesitation the trees that have the slightest defect, if he thins heavily in the average wood, he will obtain partial regeneration and induce irregularity—the selection system. Since, on the other hand, the amount thus realized will be considerable, little (of the felling budget) will remain to be cut by volume and (regular) regeneration fellings will never occur, instead only a culling under selection fellings of all kinds of mature trees.

This method is very seductive and, if properly applied, can give excellent results. It is frankly to be recommended to owners who do not have to manage their forests from the viewpoint of the highest net revenue. It is easy to apply and results in a fixed revenue during a rotation; but it appears questionable for owners who desire (in their fir stands) an investment which must yield a rate approximately equal to real estate and having the same advantages of security: three per cent, for example. This method can be criticized as absolutely lacking in data on the total volume which the normally constituted forest must contain. It is, to be sure, said that the normal condition exists when the volume of the large is to the volume of the average wood as 5 is to 3. This is an insufficient assertion, for under it a hectare which contained one large tree of 5 cubic meters and another average tree of 3 cubic meters would be normally constituted. A conception of total volume is thus absolutely essential, and especially for the private owners it is felt that a knowledge of the yield rate is equally indispensable. It is desirable for a private owner to know what rate the capital invested in forest property could or should return—this property, principal and interest, being for him a commercial enterprise. Some authorities dissent (from this viewpoint): they say the forest only yields 1 per cent; others say 2 per cent; others 3 per cent; others even more. . . . this rate, (often) remaining unknown, depends on a number of factors. . . . Many foresters think that private owners have no object in growing fir more than .4 meter (16 inches) in diameter; others advise going up to .6 meter and more. On what are these figures based? What often happens during the life (history) of a privately owned fir stand from a variety of treatment, from cuttings, from immoderate fellings following mere thinnings that have been too conservative? How often could be cited (forest) property too conservatively administered, full of fine trees and splendid stands, where, fearing to overcut, they have not cut enough? What happens? This owner only secures but a minimum revenue; the growing stock accumulates until some fine day he dies or is pressed for money; a lumberman turns up, offers what appears (in relation to past returns) to be a high price for the property and buys it. This purchaser, without regard for forest esthetics and unwilling to allow his capital to be idle, cuts clear, or almost everything, and generally realizes very high profits. Quite often one sees forests more or less frequently logged destructively or even cut clear. While this may make fortunes for speculators, it is the end of our (private) forests. Why should this occur with fir stands which yield almost as good returns and are almost as safe as other forms of investment?

Research on this subject and methods for maintaining (such stands) form the object of this study. It is simply the development of procedures and methods of investigation used since 1892 in the treatment of a little fir stand in the Vosges at an average altitude of 600 meters on *grès vosgien*. General stock-taking was made in 1892 and in 1900 and showed per hectare: In 1892, 320 trees containing 198 cubic meters, with 19.9 square meters of basal area; in 1900, 359 trees measuring 214 cubic meters, with a basal area of 21.5 cubic meters. From 1892 to 1900, 62.64 cubic meters were cut, indicating a growth per hectare and per year of 9.83 cubic meters. With this explanation, we will describe in detail the operations and experiments made to determine the theoretical composition and normal type of stand, as well as the yield and method of recruiting it.

PRELIMINARY OPERATIONS

Map.—At the start a detailed and exact map must be drawn. The ground relief may be represented by contour lines simply established by means of an aneroid barometer. All the variations of ground will be shown: thalwegs, ridges, roads, etc.

Compartments.—The forest is then divided into compartments having good natural boundaries and each connected by logging roads. In principle their area should not exceed 10 hectares They should include stands either homogeneous or not, but the fixed factors of production (exposure, quality of soil, etc.) should be about the same for each compartment.

General Stock-taking.—The stock-taking by compartments of all the growing stock must be made by diameter classes of 5 centimeters, measured at breast height, beginning with 20 centimeters. (Stock-taking costs about 1 franc per hectare.) The volume calculations will be made by means of appropriate volume tables. . . .

BASIS OF MANAGEMENT

With good compartment division and a complete inventory, it is then necessary to determine:

1. The exploitable size.
2. The ideal or normal type of stand.
3. The yield.
4. The recruitment of the yield.

1. *Fixing the Exploitable Size*

The basis of this determination for the private owner should be the rate of return which he desires his capital invested in the forest property to earn, as, for example, 3 per cent. Here we have a dangerous circle. Practically the rate results from the yield and from the existing growing stock—two factors which are themselves dependent on the exploitable size—and (consequently) the problem apparently only can be solved by successive uncertainties. In thus proceeding, we have found that when using an exploitable size of .5 meter (diameter) the return in the forest, under consideration and under the conditions described below, will amount to 3.05 per cent. Accordingly, this (financial) diameter of .5 meter has been taken as the exploitable size. Nevertheless, it is very interesting to know the rate of the various trees of different diameter classes; this is quite valuable in order to determine if the trees .5 meter and above should not be conserved because they are still growing vigorously. To determine this rate, it is necessary to know (*a*) the time necessary for trees of each diameter class to pass from one class to the next highest one; (*b*) the stumpage price per cubic meter for (trees of) each diameter class.

(*a*) *Time necessary for trees of one diameter class to pass to the next higher class.*—This time, under (*a*), varying essentially with the density of the stand, cannot be accurately determined; nevertheless, it is obtained with a certain approximation by analyzing tree boles normally spaced (diameters of crowns equal to fifteen times that of the boles, as explained below). Without making a complete tree analysis, which requires felling and long calculation, this can be rapidly determined by means of Pressler's borer . . . without injury to the tree. . . . If the ground slopes, the boring should be made parallel with the contour lines because of the phenomena of eccentricity of fir rings; the number of rings counted on .025 meter will give the number of years which it takes the tree to grow from one 5-centimeter diameter class to another. This method is not accurate, and the less so the fewer trees are used.

When two inventories are available, the determination can be made more exact, for all the trees of the forest can be counted; for example, a stand whose stock-taking, done at eight-year intervals, is as follows:

Diameter, centimeters	Number of trees 1900	Number of trees 1892	Remarks
20	10,206	6,826	The second column includes the trees counted in 1900 and those which were cut from 1892 to 1900.
25	6,521	5,575	
30	4,700	3,437	
etc.			
Total......	27,559	20,160	

In 1900 there were 27,559 trees of all diameters; in 1892 there were 20,160; the difference, 7,399, evidently represents the wood which in

1892 was less than 20 centimeters in diameter and which from 1892 to 1900, or in eight years, has grown to a 20-centimeter class. Since there are 10,206 20-centimeter trees in 1900, of which 7,399 came from the 15-centimeter diameter class, the difference, 2,807, represents the material which in 1892 was already 20 centimeters and which has not as yet passed this class.

On the other hand, there were in 1892 6,826 trees, 20 centimeters of which, 2,807, have not passed the class; the difference, 4,019, have then passed the class in eight years and entered the 25-centimeter class. For a tree to reach the 25-centimeter class it required $\frac{8}{4019}$ years, and for the 6,826 trees it will require $\frac{8}{4019} \times 6{,}826 = 13.5$ years. Reasoning similarly for the following age classes, 4,019 trees have passed in eight years from 20 to 25. In 1900 there were 6,521 trees 25 centimeters; of this number 4,019 came from the 20-centimeter class; the difference, 2,502, represents the trees which were 25 centimeters in 1892 and which have not passed the 30-centimeter class. In 1892 there were 5,575 trees of 25 centimeters, of which 2,502 had not passed the class; the difference, 3,075, thus passed in eight years to the 30-centimeter class, and for the 5,575 trees of 25 centimeters to pass it requires $\frac{8}{3073} \times 5{,}575 = 14.5$ years, and similarly for the other classes.

We have thus found, after having corrected several discrepancies of the curve, the results given in column 5 of Table 1. The figures obtained are naturally subject to revision when they differ materially with the density of the stands, and we believe that when the trees are properly spaced, as we intend progressively to do, they will pass into the different classes in less time.

TABLE 1

Diameter, centimeters	Volume per tree, m. c.	Price per m. c., francs	Value per tree, francs	Time required to pass to next age class, years	Increment per cent in money, francs
20	.27	10	2.70	12	....
25	.45	11	4.95	13	4.77
30	.69	12	8.28	14	3.74
35	1.02	13	13.26	15	3.19
40	1.43	14	20.02	16	2.61
45	1.90	15	28.50	17	2.10
50	2.42	16	38.72	18	1.72
55	2.99	17	50.83	19	1.40
60	3.60	18	64.80	20	1.26

(*b*) *Price per cubic meter standing for each diameter class.*—According to the results of sales and the data furnished by sales, the price per solid cubic meter standing averaged from 1892 to 1900 that given in column 3 of Table 1. With this data and by means of the compound-interest formula $A = a\ (1.0x)^n$, where A = final capital, a = initial capital, x = interest rate, and n = number of years, one can calculate at what rate of interest (x) the amounts representing the values of the trees of each class yields. Table 1 gives the results of the calculations. It is evident from this table that the rates . . . decrease very rapidly as the sizes of the trees increase.

As we shall see later on, in adopting an exploitable size of 50 cm. in diameter, the rate of interest in money for the whole forest, reckoning from the passing to the 20 cm. size of the wood not mentioned, the value of the soil, fixed charges, etc., is 3.05 per cent, and that obtained with the wood which does not exceed 50 cm., because it takes 19 years to pass from 50 cm. to 55 cm.; but if . . . it appears that they can pass from 50 cm. to 55 cm. in much less time, it would be best to hold them until they do not bring the yield to less than 3.05 per cent; one could keep a few of the best trees, 50 cm., 55 cm., and even 60 cm. and above.

2. *Normal Stand*

Knowing the normal exploitable size, what will be the composition of a stand in trees of all sizes to assure the permanence of the forest and to obtain the largest return with the smallest possible growing stock?

The solution of this question depends on knowing (*a*) the growing space per hectare which it is necessary and sufficient to give to each tree diameter class; (*b*) the number of trees of each class which must be raised in this space.

(*a*) In default of exact data on this question and until better ones are found, one can admit, as most foresters do, that it is necessary to give to each diameter class equal space. It is the fundamental principle of the treatment of the regular high forest; it is also explicitly admitted by the French administration for the calculation of yield in the selection forests; it is also admitted for the management of the Saxon forests.

It is possible that it would be well to allot a larger area to the large wood than to the younger age classes. If in reality a large tree is removed, the area freed (of timber) is occupied, first, by the bordering crowns which become larger; secondly, by the seedlings which develop in the center of the opening. These seedlings do not entirely occupy the area covered by the large tree.

In the case of the forest taken as an example, the small and average wood are in demand and always merchantable because of the proximity of the factories which utilize them, notably the pulp mills. This small and average wood, moreover, grows individually at a high rate; they guarantee the security of the forest against accidents, windfall, etc., and assure, in a certain sense, its perpetuity. One can, then, without fearing to make sacrifices, admit that each class must occupy equal surfaces. However, it is *not* necessary to allot a space to young fir with a diameter less than 5 cm.—such can grow as an understory.

There are, then, from 5 cm. to 45 cm., inclusive, nine classes, and the surface occupied by each will be per hectare $\frac{10,000}{9}$ *mq.* = 1,111 square meters.

(*b*) As regards number of trees in each class, there is presented the most important problem, namely, the most favorable spacing to give to the trees. This spacing, which we will designate "normal," must be both the chief guide in management and the "director of markings"; it is the cornerstone of the edifice, and it is by this notion of spacing that one will succeed, without doubt, in finding the law of the separation into classes—a law which is being ignored absolutely, as Hüffel has said at the silviculture congress. In agriculture and in horticulture the law of the spacing of plants plays a very important rôle. . . . In silviculture, also, a maximum yield evidently corresponds to a certain spacing; this is not entirely the maximum yield of gross material given by each diameter class that it is necessary to find, but rather the maximum yield in money per age class.

In order to determine this "normal" spacing, we have proceeded with two series of experiments. One determines the direct determination by means of a plumb-bob of the crown (width) of trees which appears "normal" from every point of view. The other depends on the stand, as a whole, suitably selected. Here are some details on the second series of experiments:

When a stand is too open, the soil becomes covered with grass or seedlings, and it then appears that the mature trees do not utilize all the productive forces coming either from the soil or atmosphere; when, on the other hand, the stand is very dense, there will be on the soil neither woody nor herbaceous undergrowth. In this case all the productive forces are well utilized by the trees, but are divided among too many stems; it might even happen that most of them would only receive enough to keep them alive and that they would not increase more than a theoretical amount. . . . There is in this case a poor utilization of the growing forces. We feel that the normal spacing for the fir is that between these two conditions—that is to say, when the soil commences to become covered with vegetation, when seedlings grow but do not develop. At this limit, moreover, the trees are well balanced and vigorous.

From the result of our experiments, extending over areas of sufficient size and diversity of conditions, we found that when the space separating the crowns exceeds fifteen times the diameter of the bole, the soil is more or less covered with grass or with advance regeneration; on the other hand, when this spacing is less, the soil being either bare or covered with seedlings which cannot develop, all conditions of the height of cover are about equal.

With this explanation, this is how we proceeded to determine the average spacing of the trees in the stand appearing "fully stocked":

Let x be the average relation between the diameters of the crowns and the diameters of the bole d, d', d'', d''' of the boles; S the surface of the ground experimented with; s the basal areas.

The diameters of the crowns are dx, $d'x$, $d''x$, $d'''x$ . . ., and if one considers that the crowns are irregular, but that, the stand being complete, their projection will occupy the entire soil surface, one can then admit, without making an appreciable error, that the surface of each crown is equal to that of a square having for the sides the diameter of the crown; the total area of the crowns will then equal $d^2x^2 + d'^2x^2 + d''^2x^2$, an amount equal to the surface of the soil, or $d^2x^2 + d'^2x^2 + d''^2x^2 + \ldots = S$; from which $x = \sqrt{\dfrac{S}{d^2 + d'^2 + d''^2 \ldots +}}$, or, the basal area S being the sum of the sections of the boles at breast height, one has $\dfrac{\pi d^2}{4} + \dfrac{\pi d'^2}{4} + \dfrac{\pi d''^2}{4} + \ldots = S$, or $d^2 + d'^2 + d''^2 + \ldots = \dfrac{4S}{\pi}$;

hence $x = \sqrt{\dfrac{S}{\frac{4S}{\pi}}} = \sqrt{\dfrac{\pi S}{4S}} = \sqrt{\dfrac{0.7854S}{S}}$; for example, with a surface of 3.18 hectares and a basal area of 21.813 square meters, we would have $x = \sqrt{\dfrac{.7854 \times 3.18}{21.813}}$.

With this very simple formula, one can then easily determine this average relation by careful stock-taking (on the carefully chosen experimental areas), including all diameter classes. From our experiments, we have concluded that with a relation over 20, the trees have their individual shape and not their "forest" form.

The two series of tests having given approximately the same results, the ratio 15 has been adopted. With this average ratio of 15, one can keep the young stands sufficiently dense, the young trees grow sufficiently in the bole, while the mature trees have a sufficient area to develop their crowns, important in respect to their individual rate of growth. This ratio gives the criterion for good cultural operations; not to have the young trees too dense, . . . but dense enough to prune the bole; thus two trees 20 cm. in diameter must be spaced 20 cm. × 15, or 3 meters; 2 trees 40 cm., 40 cm. × 15, or 6 meters; a tree 25 cm. and a tree 45 cm $\frac{25+45}{2} \times 15 = 5.25$ meters.[2] It is now easy to determine the surface occupied by the tree of each diameter class and to deduct the number which must be removed per hectare. The results obtained are figured in the table which follows, as well as the volumes, basal areas, and price. This table gives the normal condition after the felling:

TABLE 2.—*Normal Condition at the Beginning of the Cutting Cycle*

D. b. h.	Distance between boles.	Surfaces occupied by each age class, sq. meters.	Number of trees per class.	Relationship between number of trees of each class.	Volume per tree, cu. m	Total volumes, cu. m.	Price per cu. m., francs.	Values.	Basal areas.
15	2.25	1,111	219	....	....	......	..	....	......
20	3.00	1,111	123	1.77	.27	33.18	10	332	3.864
25	3.75	1,111	79	1.55	.45	35.75	11	393	3.878
30	4.50	1,111	55	1.43	.69	37.74	12	453	3.888
35	5.25	1,111	40	1.40	1.02	40.64	13	528	3.848
40	6.00	1,111	31	1.29	1.43	44.29	14	620	3.875
45	6.75	1,111	25	1.24	1.90	47.44	15	712	3.975
			353			239.04		3,038	23.348

[2] M. Algan (E. & F., XXXV, 1896, p. 162) gives as a result of his experiments: $D = 10d + 1m$, where D is the distance between the two trees; d the d. b. h. of these trees. This formula gives the same results as our S for trees 20 cm. in diameter, but less for larger trees and more for smaller trees.

D. B. H.	$D = 10d + 1$	$D = 15d$
15 cm.	1,600 trees with 216 cu. m., worth 1,944 frs.	1,976 trees with 207 cu. m., worth 2,403 frs.
60 cm.	204 trees with 735 cu. m., worth 13,230 frs.	111 trees with 400 cu. m., worth 7,200 frs.

Such would be, then, for the forest under consideration, the normal type; it is toward this type that the cutting must tend to bring the stand.

According to inventories on 15,000 hectares of Vosges fir stands, Liocourt found a constant ratio of 1.4 between the number of trees of two bordering diameter classes.

The material is then minimum at the time. If the cycle adopted for the return of the felling is five years, the average material per hectare will then be 239 c. m., increased by the growth during $\frac{5}{2}$ years, or during 2½ years; it will attain then about 265 cubic meters and include 399 trees or, in round figures, 400. One can determine if all the fir stands belonging to private owners have this average volume per hectare.

In the Vosges, on 20,000 hectares of native forests, where this entire stand has been measured (20 cm. and over), the average volume per hectare is, on an overage, 317 cubic meters, and varies from 196 to 390 cubic meters.

3. *Yield*

If the stand is normal, one can obtain the yield by applying the method proposed by Burel, formerly conservator at Epinal. This yield comprises trees rendered available each year by their passage to the higher age class.

The 219 trees of 15 cm. require 12 years to pass wholly into the 20 cm. class, and this class must be represented by 123 trees; one can dispose in 12 years of the difference, namely, 219–123 = 96 trees of 20 cm., or per year $\frac{96}{12} = 8$, and so on. Table 3 gives the results with the application of the volume and price.

TABLE 3.—*Yield Calculation*

D. b. h.	Normal number of trees	Volumes	Time to pass to next age class	Number of trees available during period	Per year	Volume, cubic meters	Value, francs
15	219	......	..	..	.....	.....	......
20	123	33.18	12	96	8.00	2.16	21.60
25	79	35.75	13	44	3.38	1.53	16.83
30	55	37.74	14	24	1.71	1.17	14.04
35	40	40.64	15	15	1.00	1.02	13.26
40	31	44.29	16	9	0.56	0.80	11.20
45	25	47.44	17	6	0.32	0.61	9.15
50	...	......	18	25	1.39	3.36	53.76
	353	239.04			16.36	10.65	139.84

To get the rate of return corresponding to a gross revenue of 139.84 francs (or in round numbers 140 francs), it is necessary to subtract the various annual expenses—taxes, protection, cost of administration, road maintenance, reforestation, etc. This amounts on an average to 15 francs. It is, besides, advisable to allow for accidents which may happen to the trees and which diminish their value, such as windfall, snow breakage, fungus, etc. Placing this loss at 10 per cent (of the annual increase), it will be 14 francs; this leaves a final net revenue of $140 - (15 + 14) = 111$ francs.

On the other hand, to the value of the material of 20 cm. and over (3,038 francs), it is necessary to add the soil value and that of the young growth under 20 cm.; this value can be estimated at 600 francs. The total initial capital then becomes $3038 + 600 = 3,638$, and the net rate of interest yielded $\frac{111}{3638} \times 100 = 3.05$ per cent.

The yield in number of trees given in Table 3 is, in round figures, 16 trees, of which 8 have the size (I) 20 cm., 5 the size (II) 25 to 30, and 3 saw timber (III), 33 cm. and over. If it is considered that the size of the II class is not fixed, and that then saw timber (III) contained some wood of 30 cm., it is certain that this proportion (*i. e.*, 8:5:3) is quite similar to certain eighteenth century working plans, as, for example, in the plan of January 31, 1750, for Rambervillers, where it is said: . . . "Permit to cut 6,000 fir trees, of which one-half are Class I, one-quarter Class II, and one-quarter Class III."

4. *Recruiting the Yield*

The normal type of stand is established and the yield fixed; it now remains to recruit this yield among all the diameter classes, proportionally to the figures in columns 6 or 7 of the preceding table, according to whether the yield is by trees or by value.

This kind of recruitment is assuredly quite delicate; many foresters consider it even impossible. We feel, on our part, that one can in the marking come near this aim, with a sufficient approximation . . . very generally, when the tabulation of trees marked is compared with the stock-taking before the cutting, one finds that trees of all classes have been marked in the proportion found in the stand. Then, if the stand is "normal" and if one cares to see to the proper spacing of the trees—that is to say, to have them spaced approximately 15 times their diameter (d. b. h.)—one is greatly surprised at having recruited his yield about in the proportion desired.

During the marking one can, on the other hand, rapidly keep count, if the three classes of trees (marked) are in the proportion 8:5:3.

CARE OF STANDS NOT NORMALLY CONSTITUTED

If the forest is not normally stocked, we must reduce or increase the figure of the yield, so as to arrive at a normal type within a longer or shorter time, and one will recruit the principal yield in the diameter classes with excess numbers (or *vice versa*), having always as a main guide the normal stem spacing. The most practical method of taking in at a glance the diameter classes of trees that are in excess or deficit is to draw on one sheet with black ink the number of trees existing and with red ink that of the trees that should be there. This can be done for all compartments and for the whole forest on cross-section paper and should be consulted in marking. It can happen—in fact, often happens—that the inventory of a compartment shows the poverty of some diameter classes and consequently the necessity of only cutting dead or dying trees in this class. If, on the other hand, the trees of these diameters, instead of being evenly distributed, are missed on any one point, they should be cut according to the spacing formula.

SUSTAINED YIELD—MARKING—ROTATION

In general, private owners do not search after a regular annual sustained yield. . . . If in doubt whether to cut one tree or another, a glance at the two curves, one in red ink representing the normal condition, the other in black ink showing the actual stand, will suffice.

After the felling is marked, it can be plotted, and it will generally be a surprise to see that the wood of all diameter classes has been removed in about the proportion desired. If the figure of the yield is approximately attained, one can stop there; but if a good deal remains, one will pass to the next compartment until the fixed amount has been obtained. In this case the yield will be sustained as to volume and one will sacrifice the prescription of running over the forest in a given time.

If, on the other hand, it is desired to make a rule of returning periodically over the same area at intervals fixed in advance, it will be necessary to sacrifice the sustained yield. One will then determine the length of the cutting cycle and establish such a regulation of cutting that the entire forest may be "run over" during this cycle. In this regulation . . . one may indicate the probable amount to take out in each compartment.

Cutting Cycles.—The cutting cycle in theory should be very short, five or six years, so as to be able to approximately recruit the amount of the cut without opening up the stand too much without producing "fellings." If the cut equals, for example, 4 per cent of the stand, with a cutting cycle of five years, one will have to remove 20 per cent of the volume; with a cutting cycle of 10 years, 40 per cent must be removed, and with a cutting cycle of 15 years 60 per cent, which certainly would be far too much from the cultural viewpoint. A short cutting cycle permits (on the other hand) the removal of diseased and dying trees before they have lost too much in value. We cannot do better (in treating this subject) than to quote M. H. Biollet, forest inspector at Couvet, Switzerland:

"Who will contend," he said, "that light and frequent cuttings are more in conformity with physiological laws and are better for the forest or for the soil than operations at long intervals and, moreover, of more moment than the intervals wider apart? If it is desired to have trees well formed, with homogeneous wood, with regular texture, avoid cutting for (rapid) growth; it is necessary that the transformation should be slow and evenly graduated."

REVISIONS

The forest is continually changing and growing. In its evolution . . . the forester . . . must make new stock estimates of the entire volume. This stock survey, compared with former ones, will permit the determination of the increment and a check on the regulation, a revision of all the calculations enumerated in this study and the establishment, if necessary, from new management data, of a new yield. In selection forests an inventory may profitably be made before each felling, or *every five or six years*.

CONCLUSIONS

As has been seen, the method proposed is based on the normal spacing of the boles; it does not imply in itself any particular form of stand. It can be applied equally well to a fir stand, whether selection or even-aged. In the regular fir stand the trees of each age class, figuring from a normal-yield table, will be grouped together. In the selection fir forest, these trees will be mixed irregularly.

In both cases it is clear the aim to follow is to have such a condition that the largest volume will be produced with the smallest possible growing stock; it is known that the means of arriving at this condition and of keeping it so is by normal spacing of the boles. The method *gives up completely* the idea of rotation, even as a means of fixing the yield. It tends to an assuredly intensive silviculture and responds to the needs of a time when the scarcity of sawlogs of all sizes is making itself felt. . . . To sum up, in the case of the forest considered our method leads to a type of stand with an average hectare in the middle of the cutting cycle of 400 trees 20 cm. and over, scaling 265 cubic meters. This stock produces annually 10.65 cubic meters, or 4.02 per cent on the volume, if one includes the trees not inventoried passing to the 20 cm. class, and a money return of 3.05 per cent, allowing for the soil value, costs, etc.

It is carried out automatically (so to speak) by the application of the spacing formula, which is the fundamental idea.

COMMENTS ON KNEIPP'S PAPER, "THE TECHNICAL FORESTER IN NATIONAL FOREST ADMINISTRATION"

By Burt P. Kirkland—

Having been for four years Supervisor of a National Forest where technical men constituted the largest percentage of the force of any in the United States, it is impossible for me to let the inference of Mr. Kneipp pass unchallenged. My experience in those years was directly contrary to the results inferred by Mr. Kneipp.

The real efficiencies springing from employment of technical men arise from other sources than can be expressed by consideration of any one or more mere details of the work. Two principal sources of efficiency may be mentioned:

(1) Due to his liberal and scientific training, the technical man is adaptable to many more lines of work, both in field and office.

(2) Employment of a liberal number of technical men on the National Forests is an indispensable preliminary to furnishing an adequate number of capable men with field experience to fill the ranks in the higher offices of the Forest Service and important positions in private life.

Discussing (1), I affirm that lack of success in the use of technical men is due to lack of skill in their employment. No educational institution can turn out men who can, the moment they step into a supervisor's office, do all kinds of forest business mentioned by Mr. Kneipp. It would be a waste of time for institutions to do so, even if it were possible, because the would-be forester can, if given an opportunity, acquire this detailed information *right on the job at the same time he is giving full return in service for the salary he receives.* It is equally truthful to say that the man directly from civil life cannot do all this business either and will take longer to learn how. Furthermore, out of ten untrained men from civil life who can pass the forest ranger examination, nine never will be able to handle more than a few branches of the work, while from ten trained men five may be able to do so.

The great bulk of the swivel-chair work in the Forest Service arises irrespective of whether the men are trained or untrained. So long as maximum centralization instead of maximum decentralization remains the guiding principle in forest organization, red tape will increase. If there is any superiority in this regard, of one over another, as between technical and non-technical men, it is that in the case of the trained foresters enough love of the forests and remembrance of the field will persist to get some of the expenditures actually into field-work. Without this leaven it seems really possible that in time the mill might come to grind the same grist over and over, or that enough material could be gathered in summer field trips to make unnecessary any permanent employees in the field.

Of course, the fact is that much office work must always be done. Otherwise the best methods of doing work cannot be spread among many men, and the work of one man cannot be made available for his successor to build upon. Working up timber surveys and numerous other field data requires a surprisingly large amount of unavoidable office work on maps and, to a minor degree, on reports. Here is where the writer got overwhelmingly better results from trained men. With these on his force it was possible to throw the entire force, except one or two clerks, into the field in the best field season, and draw all but one or two rangers into the office when no field-work could be done efficiently. The result was that the total loss of time for bad weather was not more than five to ten days annually for the entire force. On every other forest where he has been stationed, including one year on a grazing forest in Montana, large losses of time for bad weather occurred. Many members of the permanent force were of no use in the office, and simply stayed in the field looking after occasional items of business with the public, most of which could have been done by correspondence, and all by trips at intervals of a month or more. The result was somewhat as related to me by one ranger, who was stationed for three months at a certain location where a cabin was to be constructed. During this time five days were suitable for outside work, which he performed and charged to the improvement fund for construction of the cabin. The remaining time was spent waiting for better weather and charged to the general expense fund! Of course, just as poor use can be made of technical men; but it is unnecessary on a properly organized forest, especially where field-work is performed rather ahead of immediate demands.

(2) The second necessity for technical men on the forests is equally urgent. Few men can properly judge quality and quantity of field-work who have not had ample experience themselves. Employment of technical men in numbers forms an ample reservoir from which to secure men qualified by experience for higher positions. If the higher positions are not filled by professional foresters and such other pro-

fessional men as are necessary, they will in the end be filled by professional politicians. The only safe insurance for continuity of forest policy is unswerving adherence to employment of trained men in all positions of authority. A quarter century of such a policy will render the Forest Service fairly safe from the political spoilsman.

Professor Toumey says, in his discussion of Mr. Kneipp's paper, that judgment on so important a subject should not be made a matter of mere opinion, but should be determined by careful study of past results from employment of each class. It is therefore advisable to set forth a few results as shown by careers of technical men who obtained their early experience on a National Forest. Not all of these subsequent careers have been with the Forest Service, but so long as good work is being done that does not matter. The early attitude of the Service in assisting its men into private positions for the sake of extending the cause was far preferable to the present position of obstructing movement to and from the Service in every way possible. Following are a few subsequent careers of trained men who were employed at the beginning of their careers on the forest administered by the writer:

1. A technical man started on forest as day laborer, ended as ranger in charge of trail crews, timber-survey parties, and the like. Now in tropical forestry earning $4,000 to $5,000 annually. Attributes his success in considerable part to his practical woods experience, combined with technical training.

2. Another technical man started as day laborer during his vacations, gained varied experience in timber-survey work. Now in tropical forestry earning $3,000 per annum.

3. Two other cases of technical men, started as field assistants, ended as rangers. Went into private work and became logging engineers of acknowledged skill. Now logging and mill superintendents at some $3,000 per annum.

4. Two other men obtained early woods experience in similar ways, now university professors.

5. Two other men of like field experience, which gave them intimate knowledge of timber as it grows in the Pacific Northwest, went first to a district office and then to the Madison laboratory, where they have been most successful in handling important war work. One of them is now in charge of extremely important work in the Spruce Production Division of the Signal Corps.

6. Three other men who gained several years of experience on the above forest have been trusted and essential employees of the district office, until one lately went into military service.

7. Another man became a deputy supervisor.

All of the eleven men mentioned above started as laborers, field assistants, or guards, and include only those with considerable experience on the same forest. There are other successful men who started as forest assistants. There are also a large number who had brief experience on the same forest, but whose careers have not been followed, and in any case owed little to the experience gained there. All of these men were profitable to the Service, while preparing themselves for more important positions. Their ambition was the only spur necessary to secure quality and quantity of work. They had no better opportunities than untrained men who worked with them, but their training enabled them to grasp opportunities as they came. It was the policy to push every man on to more responsibility as fast as he could take it. When the forest organization no longer offered opportunities measuring up to ability and experience of the men, they were passed on to the first improved opportunity that offered. The compensation for their loss was that other ambitious men had been prepared as understudies ready to take up the work they left. Where opportunity lies these capable men usually congregate.

Too much emphasis cannot be laid on the point that these men were giving good service all the time they were preparing for higher responsibilities, and that the organization of which they were a part equalled any in the district in efficiency.

Particular note should be made of the number who later went successfully into private work. *The writer does not hesitate to affirm his belief that if the same policy had been followed on all National Forests the entire lumber industry would now be largely under technical control,* providing the educational institutions could have furnished the men. We all know that announcements of the Forest Service restricting employment of technical men led to a slump in attendance at the schools which before had been making rapid strides forward in attendance. The institution where I am now employed cannot furnish half the demands of private industry for men; but even so, every man is sent forth into private employment with fear and trembling, because, lacking any experience, they may fail in the unsympathetic surroundings, when experience under fair conditions would have insured their success. Failures discourage the employing concern from employing others and, being widely advertised, discourage other concerns also.

This discussion is already too far extended, but would be most incomplete if I did not point out that the severest handicap under which technical men labor is the false standards by which merit is recognized either in salary payment or in honor. As a matter of fact, both the salaries and the honors go to this very "swivel-chair" forester of which Mr. Kneipp complains. Mr. Kneipp himself (p. 161) very specifically repudiates any other kind of success than that laid down in his "specifications" which describe the activities of the all-around administrative officer. The technical man who cannot meet these specifications "may be able to find some niche which he can satisfactorily fill, but he will not be able to realize his highest ambitions unless he squares with the specifications laid down herein."

The man who has executive ability or its frequent substitute—skill in handling red tape according to the prescriptions of the hour—gets both the honor and the income, while the man who is able to contribute to silvicultural science may be looked upon tolerantly as a semi-failure. There is also a large class of field activities, such as timber-survey work, whose proper performance requires skill of the highest order. Since this skill is not recognized by adequate promotion in salary, men skilled in these lines cannot afford to spend a lifetime in the work they can do best, and must leave it because even indifferent performance in administrative work gets higher rewards. I am personally familiar with several misfits due precisely to this situation. I should like, then, to inform Mr. Kneipp and his cobelievers that when excellence in field-work is adequately recognized the "swivel-chair" jobs will not be so much sought after.

This subject is not without its broader aspects. Mr. Kneipp's policy of keeping employees in a state of "where ignorance is bliss 'tis folly to be wise" is already played out. An especially good example of the failure of this policy is forest industry itself. Failure to make available more liberalized training to more men in this industry, combined with improper social conditions characteristic of the timber-mine policy in forest use, has formed fertile ground for propaganda of the apostles of unrest. These doctrines, which have a basis of truth and might lead to progress if properly balanced by liberalized training in science and liberal arts, come dangerously near to overturning the foundations of industry as now organized.

It is no longer safe to deny liberalized training to any citizen capable of profiting; but to deny employment to trained men is the same as denying training. Forest industry is undoubtedly the most backward of any industry in employment of trained men. Even the Forest Service seems opposed, if we may judge by Mr. Kneipp's address. Agriculture is far more appreciative. Demonstration by farm surveys that whereas the average farmer had a labor income of less than $300 per annum, the man with high-school training received about $1,200, and the man with college training about $2,000 per annum, was sufficiently convincing of the economic value of training. Steel, electrical, and engineering industries are very nearly 100 per cent under technical control. Can it be that in forest industry alone training is of no use; that basic knowledge is a handicap? No! Technical control of this industry is rapidly becoming an assured fact. Just now it is slowed down by lack of trained men to fill demands. Presently it will hasten forward. The main purpose of such discussion as this is to hasten the advent of technical control and incidentally to warn the obstructionist to get out of the way before the steam-roller gets him.

The family troubles Mr. Kneipp mentions are no doubt serious enough. They are no worse with foresters than with trained men in engineering and other allied lines. There is no complete solution. It may be said, however, that cultured women who love nature and endure the pioneer life are not lacking any more than men. Both cultured women and cultured men, if they go in the right spirit, are needed in the backward communities. The policy of placing in these communities representatives of the Service of the same cultural stage as the people they deal with is bad. In effect, so far as action of the Service is concerned, it condemns the backward communities to continued backwardness. They should be given as many contacts with the outside world as possible. This gives incentive to promising youths from these communities to try for higher prizes than their local surroundings can give and will bring many a genius to the service of the world. It has been scientifically proven that genius develops most often where there is the most social contact. Moreover, the method of organizing work of a technical force to make efficient use of the varying seasons gives every man several months in town every year. To this every energetic citizen will in the near future be entitled. With the assistance of modern transportation, the narrowness of the city man and the countryman are alike being leveled into a universal culture, where all are equally conversant with the freedom of the countryside and intensive pleasure and culture of the cities. This is already common in the West, where it is rare to meet a man in any station of life who is not equally at home with members of his class either in country or city and who does not understand the requirements of both kinds of life. Why should the forester differ from others in this respect?

By Frederick E. Olmsted—

In discussing the rôle to be played by the forester in National Forest administration, we are prone to confuse the argument at the very start. Mr. Kneipp, in his article in the February number of the JOURNAL, chose for his title "The Technical Forester in National Forest Administration." The adjective qualifying the forester is wholly superfluous. Do we speak of the technical engineer, the technical lawyer, or the technical physician? Of course not; for the fact that a man is a physician implies that he is qualified to practice medicine, and that consequently he has had the necessary training to that end. A forester, as commonly understood in this country, is one who is qualified to practice forestry, and it is taken for granted that he has acquired the necessary technical knowledge for the practice of his profession. Let us do away, then, with the term "technical" forester, for a man is either a forester or not a forester, a district forester or merely an executive officer for a district.

We are also inclined to take a narrow point of view as to the way in which a knowledge of forestry may be acquired and to think of the forester as the product of the forest school only. This is misleading. There are excellent civil and mechanical engineers whose only training has been in field or shop, and it is not difficult to call to mind many rangers and supervisors who are good foresters in spite of the fact that they have never set foot inside the lecture-room. To my mind, there is no better forester than the ranger who has acquired the science and art of forestry through close observation in the woods, through intelligent study at his own headquarters, through an understanding of the social conditions in his neighborhood, and, above all, through constant dreaming as to how his knowledge may be applied, so that after many years his own hills may support an ideal forest and an ideal range, and that these and all their other resources may minister to a better social organism.

The forest-school graduate who is devoid of imagination is no forester at all; the ranger who dreams of trees growing as thick as hairs on a dog's back and who applies this vision to his every-day work is one of the profession.

Mr. Kneipp believes that "idealism has its proper place in National Forest administration, but its importance should not be unduly magnified." I do not believe it possible unduly to magnify its importance. Idealism is the essence of forestry. We are not delving into the ground for coal or oil, the supplies of which we shall some day exhaust. We are engaged in a great constructive task, the building up of forest resources, with the object of assuring an everlasting supply for the common good. Our field is new and untried and our methods nothing more than experiments. Without ideals constantly kept in mind the forester would soon slip down to the level of a clerk, his thoughts muddled with such details as leaving 10 per cent of the stand uncut, giving John Smith precedence over Bill Jones in the Clear Creek cattle district, or building a trail up Blue Mountain rather than down Black Canyon. As a matter of course, the forester new to the job frequently will find the path to his ideals blocked. Let him, then, readjust himself, creating new ideals, with a better chance of ultimate attainment under the given conditions. By all means, let him continue to dream, for as soon as he stops picturing to himself the future he ceases to be a forester.

It is needless to argue that the management of human affairs, control of the range, protection against fire, familiarity with land laws, and the tactful handling of personal problems are all of marked and immediate importance. That is self-evident and applies as well to other branches of National Forest administration. I fail, however, to see why such work should be classed as foreign to the forester's make-up, and I venture to say that the forester is precisely the man to handle these problems most efficiently. Are these matters unrelated to forest management? They are all essential parts of forest management and have an important bearing on the profession of forestry. In case the forester at the start of his career proves to be weak in the practical details of business administration, he should be kept at the job and forced to master it, notwithstanding the fact that an experienced clerk, a county surveyor, or an intelligent cow-puncher would perhaps make fewer mistakes temporarily.

For what end have we in view in administering the National Forests? Control of the range? The building of roads and trails? Mediation in human affairs? The selling of timber? The use of water? The disposal of land? The end is not any one of these things by itself; it is a combination of all of them, and many more, and consists in making the earth yield up its resources just as copiously as possible, and continuously, and for the best permanent good of the body politic. This end will never be achieved unless the various problems of National Forest administration are integrated and the work viewed as a whole. For this trained minds and far-seeing minds are required—minds eager to build new theories when old theories explode. In the very nature of things, foresters should administer the National Forests. No man trained for a profession is thoroughly efficient in that profession until he has served his term knocking against practical conditions. Give the forest-school graduate a reasonably free rein and put him through the mill at once.

Before contrasting the work of the man in the field with that of the forester in the office, it is well carefully to consider what each has accomplished. A study of this matter, I submit, will show that most of the real progress in the administration of the National Forests has sprung not from the field, but from foresters in the Washington office who have little chance for active work in the woods. These men, incidentally, are not strangers to fatigue, thirst, cold, indigestion, and uncomfortable skins. They have been through all that. And, by the way, I do not consider that filth and poor food are necessary factors in the making of a good forest officer, be he forester or not. These are merely things to be endured under the inexcusable and abominable conditions of life which exist in most logging camps and mountain districts at the present time. Decent logging camps will bring forth a better breed of lumberjacks, and better living conditions in the woods will call to the profession more and better foresters. When forestry is really practiced on the National Forests the present deplorable social conditions prevalent throughout most forested regions will be revolutionized, and in this the forester is directly and deeply concerned.

If it is true, which I doubt, that the forest schools are producing men ill qualified for National Forest work, then the schools should be revolutionized at once, for the remedy lies not in less training, but rather in more and different training. I am inclined to think that foresters have not been placed in executive positions to any great extent in recent years largely because of the timidity of their superior officers, many of whom were not foresters. Undue fear has obtained that the forester lacking long experience would make mistakes. What if he should? Many mistakes were made by the foresters who were the leading spirits in the Forest Service during the days of Gifford Pinchot; but I hazard the opinion that, in spite of these mistakes, the vital progressive spirit which permeated the Service in those days accomplished larger ends than any which appear upon the surface at present, when the value of the forester in forest administration seems to be doubted. I firmly believe that all important executive positions in the Forest Service should eventually be held by foresters. Without the forester's training, viewpoint, and imagination filtering down through all its forces, the Service would soon take on the tone of many another Government bureau of staid and conservative type, grinding out its business with doleful mechanical accuracy, and the National Forests would fail utterly to accomplish the ends for which they were created.

By F. A. Silcox—

District Forester Kneipp's article, "The Technical Forester in National Forest Administration," in the February issue of the JOURNAL, raises too many fundamental questions and carries with it too many dangerous implications to go by unnoticed.

The old, ever-recurrent controversy of the value of the college-trained technical man *versus* the so-called practical, experienced, non-technical man is not peculiar to the Forest Service. It is more or less inherent in all organizations. Clear thinking on the subject would compel, it seems, acceptance, as almost axiomatic, the general conclusion that, other things being equal, the most thoroughly trained technical mind gives the highest value return. Not to admit this conclusion would be to deny obvious experience and would indicate the most casual and superficial thinking on the whole subject. It would mean the glorification of rule of thumb, satisfaction with the successful repetition of past errors, the stagnation of progress, the discounting of scientific processes, and a denial of the part that the executive technician and the technical specialist have both played in the last quarter century of brilliant achievement in all fields of human endeavor.

Certainly no one will take issue with the emphasis put upon the necessity for the possession of certain qualities of character as a prerequisite to success. Integrity, personality to impress people, sympathy in personal relations, understanding of aims and purposes of the organization, ability to compromise, vision, breadth of view, ability to analyze the sincerity or insincerity of the motives of men, idealism in not too great a degree, tact and consideration, psychological sensitiveness, adaptability, and a few others are the qualities of character which the article points out in considerable detail as indispensable to the successful executive. Possessed of such qualifications, coupled with "a mastery of all the major lines of work, supplemented by numerous unnamed activities of minor character," combined with a thorough technical training, the technical forester "may aspire to any position in the organization up to and including that of forester." Does any one doubt the capacity of a man on any "battlefield" who squares with the specifications outlined? Will any one for a moment seriously argue the point that fundamentally sound qualities of character and some degree of personality are prerequisites of success either as an executive or specialist in anything? Is the diminution of technical foresters in the Forest Service organization due to the fact that they have not been generally successful because of faulty training or because of a lack of those qualities of character already outlined? Admitting a reasonable degree of both, I imagine that a competent check of the entire number of technically trained foresters who have entered the Forest Service, those remaining, and those who have left, would perhaps show that the

Forest Service itself was much at fault. Many of the district foresters and supervisors of practical experience have naturally discounted technical training, and have not only not given any real attention to attracting men of high quality, but have failed to use the men whom they have more or less accidentally secured. A layman if given a surgeon's scalpel will probably use it to peel an apple.

There has been in all too many instances just about as intelligent use of the highly skilled or trained technicians as the illustration implies. Couple this attitude with inadequate salaries, the isolation, which can, if efforts are made, be obviated or compensated for to some degree, and again refer to the specifications which must be possessed to even aspire to higher positions in the organization, and is there any wonder that there is a diminution? To discount these factors is to deal with only part of the problem. Certainly the Forest Service needs technicians both as administrative officers, executives, and specialists. The certain obvious present conditions must be remedied, however, throughout the Service before it can hope to secure and retain men who will constructively deal with its really big problems, the most important of which is the substitution of timber cropping for timber mining and the laying of a foundation for permanent forest communities through scientific forest management, which involves thorough training in the principles of silviculture, forest finance, methods of research, fire protection, wood technology, engineering, and the like. Specialists along each line will have to be used in the process of eliminating the sawdust-pile-shack-town form of forest development and secure for us eventually not simply the effective administration of the National Forests, but a comprehensive, inclusive, National Forest policy.

Grazing technicians as specialists and executives should, of course, be used when the problem involved is primarily that of grazing. Here, again, the fundamental necessity of the technically trained man is obvious. The big progress in grazing, aside from the mechanical common-sense adjustments of range allotments, has been the result of scientific, botanical, and economic analyses of the range values, the study of range management, and the like. The necessity for a course in the land laws of the country is greatly overemphasized. This phase of forest administration work is temporary and will be reduced to the minimum shortly, when titles to the land are quieted. At any rate, whenever any technical question arises in this field, whether in private, State, or Government work, the usual process is to consult a legal specialist.

The training of a forester should equip him in scientific thinking processes, so that he will know how and when to use any kind of specialist qualified to contribute to the fundamental aim of all forest management—that of creating and maintaining permanent forest communities. The charge is merited to too great a degree that the technically trained forester has been content to be satisfied with conservative lumbering rather than aggressively fighting for sustained yield as a fundamental of forest management.

Where there is a district with a "few picayunish sales and little or no timber," obviously no one would argue that a technical forester is needed as an executive over such a ranger district. Simple instructions as to how to silviculturally manage the few trees would be all that is necessary. Many such districts occur, especially in those regions in which grazing is predominant. There will be, in my opinion, many such cases throughout the National Forests, and men of more limited training can be effectively used. There will be many non-technically trained men possessing the qualities of character outlined who will achieve responsible positions, which is as it should be. It is contended, though, that the proper management of the National Forests of the country can only be accomplished under the directive leadership of men thoroughly trained in the theory and best practices of forestry.

The whole argument is one which might have been written a generation or two ago. The more or less implied discounting of the need of technicians and the failure to recognize that the real reason in most cases for not getting the right kind of technical men is due to conditions within the Service is what I definitely want to take issue with. The doctrine is dangerous. The need is urgent that high-grade technical personnel be secured by the Forest Service if it is to maintain its leadership and not succumb to that deadly, subtly inertia so characteristic of many governmental institutions.

By Hugo Winkenwerder—

The article of District Forester Kneipp in the February issue of the JOURNAL (Vol. XVI, 1918, p. 155) and comments by Professors Toumey and Spring prompt a broad discussion of a question that is of the most vital importance to the Forest Service, the profession at large, and the forest schools. Kneipp's paper covers but one of a number of important phases of education in forestry. While I quite agree with some of his general observations and feel that there is room for a good deal of discussion concerning our methods of forestry education, Kneipp certainly got off the track in his general conclusions. His chief contention, that the non-technical man is superior to the technical one, is based upon four fundamental errors, as follows:

(1) His conclusions are based upon superficial observations not supported by statistics; (2) he has a misconception of the term "forest management"; (3) he makes comparisons between items not properly comparable, and (4) he has failed to see the situation in its proper setting, or, in other words, he failed to consider all influencing conditions. The first two of these have already been discussed by Toumey and Spring. Concerning the third, he has failed to distinguish between the inherent temperamental qualities of the individual and his purely technical ability, and likewise between the major and the minor or accessory activities of National Forest work. In both of these Kneipp makes comparisons (rather unconsciously) that are not justifiable. All of what Kneipp says concerning the human side of the question is true, but to endow the non-technical man with all these qualities and deny them to a large proportion of the technical men, which he does by inference, is the false premise upon which a good deal of his fallacious reasoning rests.

It also seems very probable that Kneipp has not made a clear distinction between the genuine non-technical men and those who because of years of training in some one special field are, obviously, specialists, and hence really technicians in a very limited field. There is a considerable number of such in the Service who have a very special value, but who are lost in the majority of broad, general Service problems (and who for this reason sometimes offer serious obstacles to advancement in connection with problems to which their specialty has only an accessory or service relationship). It takes a rather fine distinction to determine which of these latter should be considered technical and which non-technical men. While they may have had very little schooling, they have had many years of training, and with it acquired a rather important, though a very limited, field of usefulness. If he had considered this relationship there would undoubtedly have been some reference to it. Everything, however, points to conclusions based upon superficial observations without recourse to any statistical data.

The management of human affairs is more a matter of temperament than of technical education. Temperament is the product of the inherited qualities of generations of ancestors modified slightly by personal experience. A *good*[1] course in psychology and a broad association with humans of any description would undoubtedly help, but unfortunately we are still a long way from the use of these as adjuncts to the technical curricula.

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[1] The word "good" is here italicized to emphasize that very few of the courses in psychology as taught in American universities are worth much from this standpoint.

As Spring has pointed out in his criticism, forest management deals with all the business of the forest. There are many minor details in the sum total of the requirements of forest management in which efficiency can be gained only by direct contact through local field experience, and hence cannot be imparted to the student in his university training. It is therefore that the non-technical man of local experience, and at the same time proper temperamental qualities, has often been able to make a better first impression than the technical man. Together with certain other conditions to be referred to later, it will perhaps also explain why so many of these non-technical men have been able to hold on to administrative positions. We must not forget, however, that the individual local problems involved in the technical details of fire protection, grazing, timber-sale management, permanent improvements, etc., are but details of the sum total of the management of the entire forest, and that all of them must be thoroughly correlaed by some one with a broad technical *understanding* of the entire situation. Many of them can be handled without a great deal of experience or education. We can train uneducated men for positions as rangers and guards in our short courses of about three months' duration to do much of this work with entire satisfaction, but their capacity is limited.

The Forest Service realized fully in the early stages of its development the human difficulties that would be involved in the management of the forests, and tried to remedy the situation by obtaining men conversant with the local problems, and who had at the same time some business ability, as the first supervisors, *and then giving them technical men as forest assistants*, upon whom they should depend for the necessary technical information. Unfortunately a large proportion of the supervisors were not as well constituted temperamentally as they should have been, and there was considerable friction. The technical man was looking forward to the supervisor's job and the supervisor knew it. As a temporary makeshift the general scheme was, on the whole, probably as good as could be formed. But it made it necessary to handle a large amount of the detailed work of the forests under rather strict instructions and regulations from the Washington office. This condition was somewhat alleviated later by the establishment of the district officers, but the idea of centralization had become firmly established and still persists. This, in the mind of the writer, is one of the reasons why so many non-technical administrative officers have been able to make good. Initiative doesn't count for what it should in the personnel on the National Forests. Too many of the details of all the phases of management and administration are dictated from the Washington and the district offices, so that an administrative officer can easily make good without it. There seems to be little incentive for iniative.

While the writer does not desire to criticize the Service for what some technical men consider a woeful lack of effort toward the establishment of working plans, and while the question of finances may offer a partial excuse in this matter, it does seem that at least some progress along this line might have been possible, even if no more had been done than to establish one single unit under a working plan in each district as an experiment and a demonstration area. While it is true that there have been some few non-technical men of marked ability, is it not true that these men had the assistance and advice of the technical men and the good sense to use it? They were temperamentally fit. On the other hand, may not the lack of progress along the line of forest management on the sustained-yield basis be due largely (1) to the fact that so many of the supervisors were non-technical men, and (2) that realizing this the central-office men felt the responsibility of a rather close direction of the field-work, and (3) that as a result of (2) the detailed central-office supervision of small local matters has become an established system.

If these things are true, will they not go a long way toward explaining why so many non-technical men have been able to make good, as well as that these men are at least indirectly responsible for the lack of progress in the development of scientific forestry? All of these are influencing conditions which Kneipp seems not to have considered.

FOREST MANAGEMENT ON THE NATIONAL FORESTS

By E. I. Terry

Professor of Forestry, Colorado School of Forestry

Benton MacKaye in the February number of the Journal has made a strong plea for improving the social conditions of the lumberjack and has pointed out those factors in the lumber industry which are responsible for the present unsatisfactory conditions. Professor Kirkland has also discussed this topic in his vigorous articles advocating sustained-yield management on the National Forests.[1]

Both Kirkland and MacKaye point out that stable employment and permanent community life in forest work cannot be realized so long as our timber resources are exploited as a mine, but can only be brought about by managing our forests on a sustained-yield basis.

But neither Kirkland nor MacKaye plainly state what, it seems to the present writer, is the fundamental reason for the failure of the Forest Service to initiate a sustained-yield policy. That MacKaye clearly recognizes this reason is manifested in the latter paragraphs of his article, but he alludes to it rather gingerly, as though feeling for the opinion of his colleagues in the Service. He is especially suggestive when he says:

> "The Government in the present crisis, and in view of labor difficulties, has already considered taking part directly in the operation of Sitka spruce for army airplane stock. By means of this policy of direct operation working plans for carefully chosen units, made *not* by the lumber companies but by the Government itself, might be carried out in cases where such plans could not be applied through timber-sale contracts. By this means the social and labor aspects of forest management could be provided for. . . . In view of the present and prospective needs for lumber and forest products for national purposes, it would seem that it might 'pay' the Government to take the initiative in the management of its own timber."

Plainly, the reason why the Government's present timber-sale policy has not been and cannot be anything more than the veriest makeshift is because the Forest Service *does not do its own logging*. This, of course, is not the fault of the Service, but of the laws and regulations

[1] The Need of Working Plans on National Forests and the Policies Which Should be Embodied in Them. Proceedings of the Society of American Foresters, Vol. X, No. 4, October, 1915.

under which it administers the forests. But it is the condition that should be squarely faced, and which the officers of the Forest Service should strive to have changed if they believe it to be true. No systematic plan of forest management can be put into execution on the National Forests until the Forest Service assumes complete control of the timber operations, whereby it can cut when, where, and how much the plan calls for and do it in the manner prescribed by the plan. No regular, consistent development of the Government's timber resources can be made so long as the Government cannot dispose of its timber except when a lumber company—to repeat MacKaye's expressive phrase—"backs a sawmill up against a forest" and buys the adjacent stand of fine timber.

We admit that there are many National Forests on which it would not be feasible to attempt even an approach to an intensive sustained-yield management and on which it would not be good policy for the Government to do its own logging. That is doubtless true of most of the Forests of Districts 2 and 4; but on the National Forests of the Pacific Northwest the conditions certainly appear to be favorable for practicing annual sustained-yield management. The logging in that region is now done very largely by companies which operate independently of the milling companies, and if the Government did its own logging it would probably have very little difficulty in finding a market for its logs. It looks as though the time has come for the Government to take the lead in building up a great permanent forest industry in that region.

[The Editor wishes to express his entire agreement with the position taken by Professor Terry, and merely to add a significant remark by the manager of one of the largest paper companies in Canada regarding the need of stable crews. This manager had followed the advice of the Editor to employ a forester and take stock and map his extensive holdings. Having spent in the neighborhood of $50,000 on this work, the question was what to do next. After careful deliberation the management came to the conclusion that no substantial improvement in the logging methods could be inaugurated until the limits were *colonized* by a population from which a stable crew, that could be educated, might be drawn.]

FOREST SURVEYS ON THE MICHIGAN STATE FORESTS

By Russell Watson

Instructor in Forestry, University of Michigan

In making a forest survey of the Michigan State forests some problems have been encountered which are so interesting that a discussion of them, with the methods of surveying used to overcome them, will, it is believed, be of some value to the profession.

State Forester Schaaf desired that the survey should collect those data needed in the preparation of working plans for the forest, the data desired to be embodied in the following maps and descriptions:

1. A topographic map, showing form of the ground by contours and indicating all culture and subdivision lines.

2. A map of the land, indicating its value for the growth of timber—that is, a map of forest sites.

3. A map showing those areas which are so poorly stocked with trees that artificial reproduction is necessary—that is, planting map.

4. A map indicating the composition of the stands of the forest—that is, a type map.

5. A timber estimate.

6. Forest description, both of the plantations and of the natural forest.

PRELIMINARY CONSIDERATIONS

Control.—The State forests average about 30,000 acres in area. They are scattered unconnectedly over the northern part of the State. The expensive geodetic surveying used by the Forest Service in extending horizontal control over the great National Forests of the West is not required here.

The Government land subdivision lines had been accurately rerun with transit and tape in connection with the construction of fire-lines and administrative work before the present forest surveys were started. The length and bearing of these lines has been determined, thus, sufficiently accurate to serve as base lines to which the strip survey lines are tied. The lines were very well marked at the time they were rerun. Indeed, fire-lines a rod wide have been built upon these lines over a large part of the forests. As a result, the lines are very easily found, which assists materially in lowering the cost of the work.

Vertical control is carried over the forest by spirit-leveling. The datum for this leveling is obtained from the nearest well-established bench-mark, either of the U. S. Geological Survey or of the nearest railroad. From this accurate spirit-level line vertical control is carried over the base lines by Abney hand-level.

Usually the base lines are a mile apart.

Control on the strip lines is obtained by magnetic compass, steel tape, and Abney hand-level.

Subdivision of Labor.—Each crew is composed of three men. The division of the work depends upon the character of the areas being covered. Usually the strip crew is composed of two men—the compassman and the estimator; but when the stand is very dense the estimator is assisted by a third man, called the computer. The computer spends most of his time in the field office working up the tree measurements and writing the results onto the forms provided for the completed timber estimates.

Both the compassman and estimator correct their own maps and place them on the office atlas sheets. It has been found that they can do this much more accurately and quickly than can a camp draftsman who does not draw the map in the field. While either the compassman or the estimator is thus engaged his place on the strip crew is taken by the computer. In this way the strip-cruising work is carried on uninterruptedly.

Camp and Travel.—Camp is made at the headquarters of the custodian of the forest, and travel to and from work is done in Fords. This is possible owing to the great number of roads and fire-lines on the forests over which a light automobile can travel. As a result, the actual time spent on strip line is increased very considerably over that possible if the men had to walk to work.

Scale.—The scale on which all maps are made is 12 inches to a mile. This scale is not very convenient, since it is not easily converted into chains. A scale of this size has been used on all the map-work done on the forests previous to the present surveys and it is not considered wise to change now. The large size of the scale, however, has many advantages in mapping; no undue crowding is necessary in order to show all the details desired and ample room is left for corrections and additions to the map. Furthermore, with the large scale there is no need of exaggerating small important details out of all proportion in order to indicate them, as is commonly done by the U. S. Forest Service in its timber surveys.

Preliminary Instruction.—The men are given several days of practice and instruction in the work before starting the strip-cruising work. Several miles of line are run, and the methods of mapping topography, need of accuracy in the work, methods of determining sites, types, etc., thoroughly discussed.

While two men are running the preliminary control lines the third man is busied at making a silvical study of the forest. This includes especially a study of the growth of the trees, of the age classes, of site qualities, of identification of brush and herbs, of relations of insects and fungi to the forest, and of those other matters concerning which questions are asked on the questionary for the forest description. This initial study, lasting only four or five days, but repeated whenever time allows, is considered to be of real worth in assisting the men to a better understanding of the forest in which they are working. The forest descriptions and the site and planting maps certainly are done better as a result of this study.

Intensity of Work.—Two strips are run through each forty, thereby making the usual 10 per cent estimate.

The forest descriptions, including the estimates, are applied to the individual forties, which are here usually the permanent compartments. If there is more than one type on a forty (usually there are at least two types on each forty), then the descriptions and estimates are written separately for each type (or lot).

TOPOGRAPHIC MAP

The lay of the land of the forests is mostly level; what hills there are here are not steep. In order to correctly portray this gently sloping land a contour interval of 10 feet is used. Mapping contours is not easy, owing to the fact that an error of but a few feet in the elevation determination of a point will often throw the location of the contour at some considerable distance from its true location. Unless the elevations along adjoining strips are determined accurately the contours drawn will not connect. To make them connect a good deal of fudging of lines must be done, with the result that a terrain is pictured that is not found in replica in the field. In order to overcome this, the error per mile of strip line in elevation is limited to five feet, and it is believed that after this total error has been distributed over the mile that no point on the line is in error more than two or three feet.

Owing to the lack of definite topographic changes and well-marked lines of drainage, the use of form lines—that is, lines drawn in the field in lieu of contours to show the form of the ground, and from which, later, contours are drawn—is practically impossible. The trigonometric computations by which elevations are determined are checked over at the end of each half mile of strip-line run. Mathematical errors are thus detected and corrected before the errors are carried far on the strip.

Compassmen are likely to read the angle measured with the hand-level with the wrong sign—that is, read an angle plus when it should be read minus, and *vice versa*. This is the common error in the work in this region, for owing to the nearly level land the correct slope of the ground is not apparent to the eye. A second Abney level reading, taken by either the computer or the estimator, usually serves to correct the incorrect reading made by the compassman.

As soon as a section (640 acres) has been mapped, the compassman spends in the office the time necessary to correct his maps, fit them together, and put them on the office atlas sheets, at least in pencil. It is the earnest effort of the crew to keep the office work as nearly abreast as possible of the field work. The field work is checked over in the office, at least sufficiently to indicate the presence or absence of any slips in the field work. If incongruities are found or unexplainable irregularities of delineation are detected, they are then corrected or explained immediately, while the region is still fresh in mind; for since there are few pronounced lines of drainage, it is next to impossible in most cases to approximate where contour lines or type lines should be drawn. One contour line cannot be used as an indicator of the location of the next contour.

The field-map form is about 8 inches by 12 inches in size and it is held in a binder (the "tatum-holder" of the U. S. Forest Service). It is ruled so that 160 acres may be mapped on it. On the same sheet and underneath the map are four ruled lines. On each line are recorded the measurements, distance, and elevation obtained during the course of the strip through the quarter section. Since there are four strips through each 160 acres, the record is directly under the strip to which it applies. This scheme has proved to be of considerable assistance in recording and applying measurements and in checking the work.

SITE MAP

A map of the quality of the forest sites is especially important to the State Forester in two ways, namely, (1) in the application of yield tables in the computation of the value of the future crops of timber,

(2) in the determination of the best species of trees to be planted on the various areas which require planting. The latter at present is the principal need of the site maps. As a result, the land is divided into its sites in relation to the trees which grow best on the sites.

The entire region is first divided into two classes—swamp and upland. These two classes, as a rule, are distinct and easily determined. The swamp is not further subdivided at present. The upland, however, is subdivided into four sites, as follows: White-pine land, or site I; Norway white-pine land, or site II; Norway pine land, or site III, and jack-pine land, or site IV. To these four sites all upland areas capable of supporting merchantable tree growth are referenced.

Although the presence of these four sites in the region is plainly evident after some travel and investigation, the location of their actual boundaries is not easy of determination when working along the strip survey line. The methods usually advocated for the determination of the boundaries of the sites cannot be well used here. The use of the height growth of the trees as the only criterion of site is out of the question, since most of the trees are but sprout hardwoods, seldom over 30 feet high and not entirely representative. Soil samples cannot be painstakingly collected during a strip survey, owing to lack of time; so the site cannot be determined by the mechanical or chemical characters of the soil.[1] The composition of the vegetation is to a certain extent a criterion of the site, but determinations of value, it is thought, cannot in this region be based upon it alone.[2] The use of the volume of the stand is practically out of the question; not only are the trees too young and small, but the stands are too ragged and disorderly to serve as site determinants.

Sites are determined not by any one of the methods advocated, but by a combination of all. The compassman mentally judges as to the quality of the soil from observation of it at various places along the strip, looks at the tree heights and rate of growth, notices the composition of the flora on the area, thinks of the topography, and by his own good judgment decides as to the quality of the site for the growth of jack pine, Norway pine, or white pine.

Crude as may appear to be this method of site determination, it was decided upon after considering the following features of the case:

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[1] Kenety, W. H.: Preliminary Study of White Spruce in Minnesota. Univ. of Minnesota Agric. Exp. Sta., Bull. 168, June, 1917.

[2] Korstian, Clarence F.: The Indicator Significance of Native Vegetation in the Determination of Forest Sites. *Plant World*, Vol. XX, No. 9, Sept., 1917, pp. 267-287, and JOURNAL OF FORESTRY, Vol. XVI, p. 107.

1. No simple, rapid method of determination of site by actual measurements or as based on collected data seemed feasible of operation. 2. The results obtained by a good man are sufficiently accurate for the uses to which they are to be put. 3. The determination of the quality of the site is made only after being referenced immediately and directly through the judgment of the compassman to the principal use to which the result is to be placed—that is, in the choice of species recommended for planting on the area. The compassman in determining the site asks: "Is this area best suited to white pine, to Norway, or to jack pine?" and for his answer he looks to the evidence about him.

The chief disadvantages of the method, it is believed, lie in the following facts: 1. The determinations are based upon nothing absolutely tangible or certain; the bases for the determination are not recorded. Seldom will two men draw the boundaries of the sites in the same place (except where the line of demarcation between the sites is sharp and very apparent, as on the edge of a swamp). There is no way to check the accuracy of the determinations except by a trip over the ground. 2. The accuracy and the value of the determinations vary with the ability and integrity of the mapper. It is not a method by which an inexperienced man can make nearly as good determinations as an experienced man.

It has been found that the one prime factor in good determinations lies in the fidelity with which the individual applies himself to the work. Thorough instruction and trials are necessary prerequisites to successful work.

TYPE MAP

Type designations and their boundaries are based entirely upon the present composition of the stand. No thought is given to any possible future forest conditions which may appear upon the areas. The type is based chiefly upon the number of trees one inch d. b. h. and over recorded by the estimator.

The type is named after that species which clearly predominates in the stand. When no one species predominates, the type is called by some general descriptive name, as mixed hardwoods, and the species represented are written on the type sheet within the type boundaries in the order of their abundance. The use of key trees, as is done by the Forest Service in some regions to indicate the type, although the trees thus used may represent but a small portion of the total trees on the type area, is not used here. No hard and fast proportoins of species are used in determining the types; all that is attempted is that the descriptions and maps shall portray the composition of the stands of the forest as truthfully as is possible.

Each tree in the region is given a color, and the type is colored after that species which predominates in the type in numbers. The general descriptive names which are used when no one species predominates are also given a color. Burned potential forest areas are typed as burned if the burn has occurred within a year or two. They are given a distinctive color.

The boundaries of the types usually are formed by fires or by quality of site.

Unless the type is very distinct, it is not mapped unless it covers five acres or more.

When two men compose the crew, the types are mapped by the estimator; when a three-man crew is used, the computer maps the types.

PLANTING AREAS

It is of the utmost importance to the forester in the preparation of a planting plan by which the work will be conducted most efficiently; that the areas in need of planting be indicated on a map. By the use of the site map and forest description, it is hoped that the species of trees best suited to the area may be determined. The number of trees of each species needed each year can then be determined and preparations made in the nursery for raising this number.

Whether or not an area should be planted depends, primarily, upon the density of the present stand. If it is too dense, planting may not be undertaken for either or both of two reasons, namely, (1) on account of the mechanical hindrance to preparation of the soil for planting the trees, (2) on account of the amount of shade which would certainly inhibit the growth of the seedlings and perhaps kill them. But the density of the shade is not the only determining factor, for whereas an acre with perhaps fifty small oaks on it would be planted, another acre with fifty small Norway pines 20 to 30 feet high would not be planted. The oak is an undesirable species and is to be replaced by planted coniferous stock; but the Norway pine is a desirable species, and it is expected that it will sooner or later restock the ground with its own seed.

Again, the quality of the site is a factor to be considered in planting, for whereas, for example, on site I underplanting might be feasible under a specified density of crown, on site III underplanting would not be feasible.

It is apparent that it is not easy to give definite and complete instructions to mappers as to what shall be classified as suitable for planting. But most of the areas which are suitable for planting are readily recognized and easily mapped, and these are the areas which are most in need of being planted, being the least heavily stocked. Other areas suitable for planting are recognized only after inspection of the type and site maps, forest descriptions, and timber estimates. The mappers are conservative and are careful not to include areas whose suitability for planting is dubious.

TIMBER ESTIMATES

Trees are tallied by d. b. h. and height. Diameters are recorded by two-inch classes, and trees one inch and over d. b. h. are included. Heights are obtained by ten-foot classes, beginning at five feet. Practically all trees are measured ocularly, since by far the larger number of them are under 12 inches d. b. h. and 60 feet high. A roughly made, simple hypsometer is occasionally used to obtain tree heights as a check upon the ocular measurements. Due to changes in density of stand, size of crowns, height of trees, etc., the actual height of the trees is surprisingly deceiving.

The measurements are kept separate for each type within the forty. The figures on the field estimate sheets are copied and summed on the office sheets by the computer. This office work is done nearly as rapidly as the field work, and at the end of the season the estimates are practically all worked up. The operation is very simple.

The office sheet is 12 inches square and represents four forties. On each forty are recorded the measurements taken on each type. Under each type, then, are recorded the measurements of the trees by species and d. b. h., with the average height for each diameter and the basal area in square feet for each diameter. The actual tally of trees is copied. From this is computed the total number of trees for each species on the type and on the average acre of the type. The proportion between the number of acres actually tallied and the total number of acres on the type is noted. Figures are not summed by forties, unless the type occupies the entire forty, but only by types (lots) within the forty.

The trees, as a rule, are so small that they can hardly be considered merchantable and their contents are not computed at this time. Spaces are left on the form, however, so that if ever desired the number of poles, cubic feet, or board feet can be recorded for each diameter and totaled for each species.

FOREST DESCRIPTION

Description of Plantations.—Under this heading is noted the density of the stand of planted seedlings as indicated by the approximate number of seedlings per acre, their average heights, age, and thrift. In case the seedlings have been underplanted, a note is made as to the need of liberation cuttings.

The estimator has ample time to notice these details, since in most cases the planted areas support few trees which have to be tallied.

Description of Native Stand.—This is the usual forest description, done in considerably more detail than is done by the U. S. Forest Service on its timber surveys, however. Not alone is the silvical description written in some detail, but notes also are taken regarding the condition of fire-lines, roads, sign-boards, and other improvements.

CONCLUSIONS

Each crew of three men will cover, on the average, about 1,000 acres per week. By the end of the week not alone has the field work been completed, but the maps have been corrected and in such shape that they can be placed on the atlas forms without further corrections. Furthermore, most of the timber estimates have been computed and summed on the office forms. The average day's run of strip line is about 2½ miles, representing about 200 acres of total area.

Immediately upon conclusion of the field season the costs of the work are summarized and maps and measurements are checked over and put into final shape. At this time, too, the forest descriptions are examined in detail and any information which they may afford which is of especial interest is taken from them.

The cost of the work is less than 10 cents an acre. This cost is low, owing to the ease of laying out the control lines and to the large amount of nearly level, open country, where there is little tree measuring to be done and sightings through compass and hand-level are easily made.

REVIEWS

Report of the Forester for the Year Ended June 30, 1917. By A. F. Potter, Acting Forester. U. S. Department of Agriculture. Washington, D. C. 1917. Pp. 36.

This report, business-like and meaty from beginning to end, was prepared by the Acting Forester, A. F. Potter, in the absence of Mr. Graves, who had gone to France on the staff of General Pershing to organize the work of the Engineers (Forest) Regiment. Every United States forester is expected to peruse in its entirety this exposé of the activities of this remarkable Service. We can here only place on record some of the salient points.

The report starts in with a very satisfactory financial statement of the operations of the Service. The receipts, increasing by over $633,000 over the previous year, with nearly $3,500,000, promise within another year to increase to four million dollars and thus make the operation of the forests appear self-sustained. This is, however, not quite true, for other funds are used to improve at least the accessibility of the forests. It is claimed that if the grazing charge were advanced to cover the full value of the grazing privilege this self-sustained condition would be attained. At present the two main sources of revenue—timber receipts and grazing receipts—participate in almost equal shares in making up the total. While the receipts for the 727 million feet cut (in another place stated as 840 million) brought in 1.5 million dollars, the sales of timber exceeded two billion feet, valued at 3.7 million dollars, the largest sales of 688 million feet, valued at over one million dollars, being made in Oregon.

The area of the National Forests has as usual experienced additions and deductions, but since 1910 the area has undergone steady reductions, and now the 147 forests contain an area actually owned by the public of 155,166,619 acres, besides 21 million acres privately owned. The largest increase, of 540,000 acres, took place in Colorado; part of the eliminations were made to increase Lassen and Rocky Mountain National parks. Land classification, with a view to eliminating agricultural lands, which had already covered over 127 million acres, was continued, 57 million having been classified during the year and 50 million remaining to be done, when comparative stability in the forest area will be attained.

The need of making the National Forests more accessible has been handsomely acknowledged by the Federal Aid Road Act, which appropriated 10 million dollars for the building of trails and roads, one million dollars available yearly. Besides, 10 per cent of the receipts are devoted to the purpose, so that for 1918 $1,240,000 were available, which probably on account of labor difficulties it may not be possible all to use. So far the Service has constructed 2,922 miles of road, 25,193 miles of trails, 23,118 miles of telephone lines, and has spent altogether in improvement nearly seven million dollars. Further improvements outside the National Forests are provided in the States in which the forests are situated by the practice of turning over to them for county roads and schools 25 per cent of the forest income, which in 1917 amounted to over $910,000. Still further benefits of co-operation between the Federal and State governments are administered by the Service in the system of forest-fire protection, under the Weeks' law, toward which $100,000 in State aid are appropriated.

The usual statistics regarding forest fires are given. The year 1916 was favorable, but 1917 was a bad one after June and "put the National Forest protective system to the severest test which it has experienced since the great fires of 1910," occasioning an emergency expenditure of over $950,000. The losses were nevertheless comparatively small.

Reforestation, chiefly of old burns, was continued at a reduced rate and increased cost, some 7,680 acres being reforested, 190 of which by seeding. The 18 National Forest nurseries are credited with containing 36.5 million plants, chiefly for own use, the free distribution to settlers seemingly being confined to Nebraska, with insignificant amounts.

Estimating of timber is mainly done as a basis for sale purposes. Up to the year of report some 21 million acres had been estimated and mapped by what is called intensive methods and 48 million extensively.

Range management comes in for considerable discussion, and the advantages of the formation and co-operation of live-stock associations is particularly accentuated. Game preservation, which is in close relation with the range, in co-operation with State authorities is favored. Some 32 new game preserves were established in National Forests.

Water-power development in forests a decision in the Supreme Court has made certain to lie with the Forest Service.

The use of National Forests for recreation purposes under charges and by free permits, more than 20,000 of which are outstanding, has in some cases become one of the major activities.

Wide as the range of activities of the Forest Service appears from the administrative point of view, it is still wider in the field of research; a mere enumeration of the problems under examination would fill a number of pages. We can cite only a few that have become important in connection with war purposes.

Upon rupture of diplomatic relations with Germany, the Forest Service began at once to plan for meeting the responsibilities which, if war followed, it should assume. The first step was to ascertain the qualifications of all male employees for various classes of service, in order that readjustments of personnel and modification of activities could be made without bringing to a halt a work no less important in war time than in peace, for especially the release for war service of such portion of its personnel as may be needed because of qualifications for special forms of activity, or such as may be spared for military service either as volunteers or under draft, and for the rendering of advice or assistance to the War and Navy departments in matters relating to the supply of materials derived from the forests and required for war purposes was foreseen.

The forester received leave of absence and was sent abroad by the War Department to make preliminary arrangements for the work of the Tenth Engineers (Forest) Regiment in France, and the recruiting and officering of this regiment were immediately begun.

Work on the wooden-ship problem included the technical use of wood; best methods of conditioning; treatment against decay and borers; substitutes, etc.; in fact, the whole field of timber physics is under consideration.

Demonstrations have shown that walnut and birch can be kiln-dried for gun-stocks in much reduced time with comparatively little loss.

In the important aircraft work the efforts of the Service included the development of methods by which spruce and ash can be artificially dried without loss of strength and toughness; tests to determine the best substitutes for these species; the study of effects of steaming on mechanical properties of these woods to develop the best conditions for bending; the selection of woods most suitable for propellers; advice and assistance on specifications; the training of inspectors of wood for airplanes.

Data for this work cannot be supplied with sufficient rapidity with the present force and equipment. An increase in funds for this work is urgently called for.

Much assistance has also been given on a variety of war problems relating to forest resources and the manufacture, purchase, and most efficient use of forest products.

B. E. F.

Incense Cedar. By J. Alfred Mitchell, Forest Examiner. Bulletin No. 604, U. S. Department of Agriculture, Forest Service, Washington, D. C. 1918. Pp. 40.

In this somewhat general discussion of our only species of the genus Libocedrus, viz., *L. decurrens,* the author has brought together many facts of value to those who desire to know more about this western tree.

A distribution map shows that the species is almost entirely confined to California, with an estimated stand of 10 billion feet board measure, and to Oregon, with less than one billion, the greatest masses of this timber being confined to the Shasta and Klamath River region, although higher yields per acre occur in the southern Sierras.

The commercial importance is shown by annual production tables giving the lumber cut of the species from 1899 to 1916. This cut varies from 2,424,000 board feet in 1902 to 22,056,000 board feet in 1913. The species, however, furnishes less than one per cent of the lumber cut of California, and the mill-run price is only about $12, only 17 per cent of the cut being clears.

The general uses are for lumber, 68.6 per cent; ties, 10.6; pencil slates, 9.2; posts, 7.6 per cent, while small amounts are used for poles, cordwood, shingles, and shakes. It is also used in a small way for pattern stock, moldings, and raisin trays. The value of the stand remaining on the National Forests at a stumpage value of 80 cents per thousand is estimated at approximately $9,000,000.

The wood is shown to be soft, light, and weak, having only about two-thirds the strength of longleaf pine. The older trees are shown to be subject to attacks of fungi, but the species lasts well in the ground (from 20 to 30 years for posts) and is remarkably free from insect enemies.

The tree is not very large, attaining a height of from 75 to 110 feet (maximum recorded height, 186 feet) and a diameter, breast high, of from 30 to 40 inches (maximum recorded diameter, 96 inches, breast high, with a yield of 9,700 board feet). This species is shown to be short-bodied and rapidly tapering and, as a rule, living to be from 300 to 500 years old.

The root-system, foliage, flowers, seeds, and methods of reproduction are discussed in a general way, and one is led to regret that more definite facts could not have been offered touching the ecological factors best suited for its maximum germination and rate of growth.

The general silvical requirements are handled briefly. Tables showing height and diameter growths and volume tables for both cubic and board measure are given. Too little work has been done on artificial forestation and nursery practice to admit of very definite recommendations relative to future silvical methods for the species.

The author is of the opinion that natural reproduction and protection from fire are all that is necessary at the present time in order to insure a perpetuation of the stand of incense cedar in its present habitat. Nothing is said relative to either the possibility or the desirability of extending its present range.

The author leaves a number of the main problems of silvical treatment for the species yet unsolved. Among these are the following: (1) Shall the species be grown in all-aged or in even-aged stands? (2) Shall we adopt a selection or a clear-cutting system? Shall we plant, and, if so, when and where? (3) Shall we adopt the shelterwood or the seed-tree method of reproduction? These unanswered problems show that much study and investigation yet remain to be done before the foresters of Oregon and California may lay down a definite plan of silvical management for incense cedar.

C. H. Shattuck.

Report of the Minister of Lands, Forests, and Mines of the Province of Ontario for the Year Ending October 31, 1917. Toronto. 1918. Pp. 158.

Ontario is still cashing her wood capital without any adequate attempt at reforestation or even conservative lumbering or preparation for either. There are 16,313 square miles under license, an increase of over 600 square miles over the previous year, and the revenue accrued was also larger, namely, $1,496,063, although the cut was reduced.

From the forester's point of view, the one bright point is the progress in developing effective forest-fire protection made last year, under the Provincial Forestry Branch, notwithstanding that the transfer of authority over this work was not made until a relatively late date. A total of about 1,100 men were engaged in this important work, including fire rangers, inspectors, and head-office supervision. The organization is to be further extended during the coming season and the supervision will be tightened up to a material extent. As with any new organization, increasingly efficient results may be expected from year to year, as the men become better trained and as those less competent are weeded out.

A total of 1,110 fires were reported, of which 68 per cent occurred before July 1. Of the fires attributable to railways, 60 per cent occurred along the National Transcontinental. Settlers clearing land were charged with 91 fires and neglected camp fires with 154.

The total area burned over was 384,164 acres, of which 19 per cent was timber land, 39 per cent cut-over land, 20 per cent young forest growth, and 21 per cent barren. The total amount of timber damaged was estimated at about 15 million feet, in addition to 91,246 cords, mostly pulpwood, and 781,685 ties.

Material progress has been made in the construction of permanent improvements, such as lookout towers, trails, telephones, portages, etc.

A beginning has also been made in securing the disposal of logging slash where this constitutes a danger to life and personal property, as is frequently the case in the clay belt.

Some 3,500 permits were issued for the burning of settlers' clearing slashes. This means a very great reduction in the danger of fire escaping and causing damage, to say nothing of loss of life.

All the statistical information is classified and tabulated.

Two other activities of the Branch are reported, namely, the provincial nursery, which is distributing plants free of charge, in addition to planting sandy areas in its neighborhood, both on a small scale, and the scouting for the white-pine blister rust, for the continuance of which, in Canada, $100,000 are asked, to be spent by a commission to be organized.

B. E. F.

Important Range Plants: Their Life History and Forage Value. By A. W. Sampson. U. S. Department of Agriculture, Bureau of Plant Industry, Co-operating with the Forest Service, Bulletin 545. Washington, D. C. 1917.

The improvement of the publicly owned range in the western half of the country is a great economic problem. In the study of this problem during the past decade the Forest Service has been co-operating with the Bureau of Plant Industry, and already several important bulletins have been published embodying the results of various field studies and leading to conspicuous improvements in range management.

Detailed information about the more important grazing plants has been in progress of accumulation for a number of years. The portion of this information deemed most useful for forest officers and stock owners who desire to familiarize themselves with the habits and requirements of the plants upon which their animals subsist has been brought together by Mr. Sampson in this publication.

Although all types of grazing lands support a variety of plant species, only a comparatively small number, compared with the whole, are important from a grazing standpoint. The valuable forage plants of a given range are those of wide distribution and abundance, which are also nutritious and relished by the stock. Other plants, although often in abundance, are unpalatable and are of little or no grazing value, while some, because of certain climatic conditions, are poisonous and seriously objectionable on the range.

Although the investigation of the species upon which the report is based was largely made in the high mountains of Oregon, many of the species are widely distributed, and the genera represented among them are of first importance on many of the natural range lands of the entire West.

The report considers only the more valuable range species, which include 20 grasses, 5 grass-like plants, and 18 non-grass-like plants. The photographs of each in natural size accompanies the description, except in cases where the general characters of one or more species of the same genus are similar.

The report is of particular interest, due to the account of the life history and the statements regarding the ecological requirements of the different species. The following points are considered in presenting the information on the individual forage plants:

1. Name of plant, both Latin and common.
2. Distribution.
    a. Characteristic zone.
    b. Most typical habitat; abundance and density of stand.
3. Usual plant associations and communities.
4. Habit of growth.
    a. Annual or perennial.
    b. Tufted growth, height growth, and character of herbage.
5. Character of root system.
    a. Spreading fibrous root, or taproot with lateral rhizomes.
    b. Depth of roots in soil.
6. Ecological requirements.
    a. Soil and moisture preferences.
    b. Drought resistance.

7. How flower stalks are sent up.
8. How fertilized.
9. When seeds are matured.
10. How and when seeds are disseminated.
11. Seed habits, strong or weak. Viability tests.
12. Period of germination.
13. Classes of stock which graze it.
14. Suitability for early or late grazing.
15. Palatability when green and when matured.
16. Time at which it is usually grazed.
17. Relative forage value.

This bulletin appears to be the first attempt in grazing literature to assemble information regarding the ecological requirements of grazing plants. Information on the points enumerated above was secured over a period of years, and in many cases the actual ecological requirements determined through physical-factor measurements.

As a means of comparing habitat requirements, the species are grouped in 3 classes, namely, those of high moisture requirements, in habiting saturated soils, such as open marshes, wide meadows, and bogs; those of medium moisture requirements, inhabiting heavy soils, which are saturated during the early period of the season, but later contain a medium amount of moisture; and those of low moisture requirements, growing on well-drained soils, open glades, and in exposed situations. It was found that about three-fourths of the most valuable species are dry-land plants and more or less drought-resisting.

J. W. T.

Fifty-seventh Annual Report of the Crown Land Department of the Province of New Brunswick for the Year Ended October 31, 1917. Hon. E. A. Smith, Frederickton, N. B. 1918. Pp. 206.

It is a matter of gratification to note from this first report of a new political administration how entirely and whole-heartedly the Province of New Brunswick is committed to its newly inaugurated forest policy.

The new Minister of Lands and Mines, Hon. E. A. Smith, with most appreciative words for the technical men, not only approves what his predecessors have done in starting a forest survey and forest service, but proposes to increase the organization to a fully equipped department, with initial appropriation of $100,000, handing over to it at least certain features of the timber-land administration. When it is considered that the whole income from the crown timber lands does not exceed $450,000, this is a generous beginning, especially as, owing to war conditions, the output has been declining and a greatly reduced cut is expected. Indeed, "a smaller revenue from stumpage is looked upon acceptably by the department, it being the opinion for many years that we were exceeding the annual growth in many localities, and heretofore too large a percentage of undersized logs has been cut. Indeed, it is becoming a serious question as to whether the government would not be justified in prohibiting certain areas from being cut at all where it is shown by the forest engineers the merchantable-sized logs have all been removed." It should, however, be stated that $30,000 of the appropriation of $100,000 is derived from taxes received from wild lands by special levy on private owners toward fire protection, and another $30,000 from the fire tax of one-half cent levied on licensed crown lands.

Among the improvements in the timber-land administration, partly an outgrowth of the forestry development, may be mentioned reorganization of the scaling, change of the diameter limit at certain heights to a stump diameter of 12 inches for spruce and 9 inches for fir, and a method of checking the fake settler in cutting pulpwood. The organization of an efficient fire-protection service is foreshadowed.

The progress of the forest survey is fully reported on 83 pages by the present director, Mr. G. H. Prince, his predecessor, Mr. P. Z. Caverhill, who organized the service, having gone to British Columbia.

So far a little over 16 per cent of the crown lands (1,245,000 acres) have been surveyed, at a cost of somewhat over $27 per square mile. The method described in detail is the usual strip survey, with base lines 2.5 miles apart and cruise lines 25 chains apart, calipering or estimating 33 feet on each side.

The only unusual addition is an attempt at soil classification by occasional spading, the idea being that upon such rather wholesale survey the agricultural possibilities may be determined—a somewhat doubtful proceeding. It will, however, serve the purpose of a, first, more or less wholesale classification and will make a more intensive examination and segregation easier.

The ambitious attempt to determine the rate of wood production for the whole province in order to gauge the cut accordingly was not continued for lack of competent technical assistance.

A discussion on the spruce-bud worm and the white-pine blister rust and the detail description of certain areas covered by the survey completes the very creditable report.

B. E. F.

Wood and Other Organic Structural Materials. By Charles Henry Snow. McGraw-Hill Book Co., New York City. 1917. Pp. 478. Illus.

In this book Dr. Snow, who is Dean of the School of Applied Science in New York University, has attempted to present a comprehensive summary of the characteristics and uses of organic structural materials. The first portion of the book is occupied with a compilation of information upon the botanical and physiological characteristics of trees, closing with a paragraph on forestry, which is defined as "a phase of agriculture, rather than of lumbering." This is followed by a chapter on the gross and minute structure of wood, which is rather involved and technical for the average engineering student, and too brief and incomplete to present very much of value to the wood technologist, especially in view of the general availability of Record's excellent work on the "Economic Woods of the United States." A chapter on "banded trunks and woods" is then followed by a very indifferent compilation of data on the commercial woods of the United States, which occupies roughly about half of the pages of the book. A subsequent discussion of the chemical composition and physical properties of woods is rambling in style and confusing to the reader, as is also a cut of a "torsion" machine and a cut of a Dorry machine for making abrasion tests of stone and similar material. In the next chapter, on the causes of failure of wood, the paradoxical use of the word "exposure" is especially interesting. This is followed by a chapter on conflagrations, which contains material of real interest, and a chapter on marine and terrestrial wood-borers, which is rather well written. The remaining chapters, on the seasoning and preservation of wood, data on oils, paints, varnishes, other coatings, and india-rubber, are a sort of literary conglomeration consisting largely of valuable material very poorly compiled. The poor typographical arrangement of this book does much to render the subject-matter uninteresting.

B. L. G.

Snow Surveying: Its Problems and their Present Phases with Reference to Mount Rose, Nevada, and Vicinity. By J. E. Church, Jr. Bulletin of the Pan American Scientific Congress, 1915-16. Government Printing Office, 1917.

In a recent paper the author of "The Conservation of Snow,"[1] and other bulletins emanating from the University of Nevada and its Mount Rose Weather Observatory, discusses the very technical problems con-

[1] Scientific American, Sept. 7, 1912.

nected with a true determination of snow-fall, or of the amount of snow available for streamflow and irrigation at the beginning of the melting season. Very wisely, the writer refrains from any broad conclusions. No one is more competent than Mr. Church to realize the difficulties in the way of accurate snow measurements; he has both the practical knowledge to surmount these difficulties and the ability to express himself clearly in writing.

The present paper by Church is not of as great interest to foresters as the earlier paper which I have already cited. In fact, it is almost wholly given up to the technique of snow measurements and cannot be said to present any results beyond those of special interest to engineers, and perhaps foresters, who may attempt snow surveys. Briefly, the present situation is:

1. That the measurement of snow-catch, in gages of any kind so far devised, is very inaccurate and gives no approximate idea, for high and wind-exposed mountain regions, of the snow available in the spring, which may contribute to irrigation. Every factor tends to make the snow-catch less than the actual fall. (At Wagon Wheel Gap there have usually been measured on the ground, in spite of evaporation throughout the winter, water equivalents over considerable areas in excess of the total recorded precipitation, and this where the gages are only exposed to mild winds.)

2. Snow surveys, to be accurate enough for streamflow prognostications, must include an enormous number of measurements, so arranged in fixed places or in survey lines as to obtain a true representation of the different topographical features of the basin, the open and forested ground, etc.

3. The Mount Rose snow sampler, a tube of 1¾ inches outside diameter and of whatever length may be necessary to reach the maximum depths of snow, has been mechanically perfected, so that under all conditions of snow and ice samples are obtained satisfactorily and with a small probable error from loss (crowding out to the sides) or accretion. Such apparatus is always most successful in the hands of its designer, but only because the latter understands its eccentricities better and uses the apparatus more carefully than others. We believe, from the great variety of conditions under which this sampler has been used satisfactorily, it can fairly be said that the mechanical problem has been solved. Universal use of such a piece of apparatus is desirable, but, on the other hand, the designing and use of new apparatus often brings to light new phases of the problem under study.

4. Although mere measurements of snow depth, if sufficiently nu-

merous over large areas, may suffice for a snow survey, since at a given season and place densities are fairly uniform (varying by about 25 per cent of the maximum, according to Church), still the measurement of the water content is much more reliable, and this alone is all that is necessary, and is readily accomplished by means of the snow sampler and weighing apparatus.

5. Snow surveys, to be of value from the engineering standpoint, should be supplemented by measurements of evaporation from the snow surface and from natural or artificial reservoirs. For the former, shallow pans filled with snow, and sunk level with the snow, if observed and refilled daily, may give a fairly good conception of the rate of loss.

The main thing that foresters should learn from this paper and take to heart is that haphazard snow measurements, or those based on only a few water-equivalent determinations for any area, are likely to be misleading and will certainly "melt into thin air" under the scrutiny of those who deal professionally with the snow problem.

C. G. B.

Forest Regeneration on Certain Cut-over Pulpwood Lands in Quebec. By C. D. Howe. Commission of Conservation, 9th Annual Report. Ottawa, Canada, 1918.

As an introduction to his study of reproduction on cut-over pulpwood lands in Quebec, Dr. Howe states that the extent of the pulpwood resources in Quebec and Ontario is practically unknown. Yet these two provinces contain the largest timber-producing area in eastern Canada. Furthermore, they have wonderful transportation facilities, both natural and artificial, and are relatively near the great markets of the world. He states that in the summary of the pulpwood resources three different lines of inquiry should be presented, namely: (*a*) stock taken of the commercial materials now available; (*b*) a study of the area of growth and reproduction of pulpwood species; (*c*) the reproduction of pulpwood species on cut-over lands.

Field studies on the rate of replacement of pulpwood material, by reproduction and by growth on cut-over pulpwood lands, were made by the Conservation Commission in the St. Maurice Valley in co-operation with the Laurentide Company and its forester, Mr. Wilson. The type of forest where the studies were made was mixed conifers and hardwoods, with occasional patches of pure hardwoods and others of pure conifers. The swamps and old burns were not studied. The average of the type studied contained the following species and in the following percentages: Balsam, 36 per cent; yellow birch, 26 per cent; red spruce, 20 per cent; white cedar, 7.3 per cent; sugar maple, 5 per cent; paper birch, 3 per cent; hemlock, 1.4 per cent; beech, 13 per cent. This type contained from two-thirds to three-fourths of the forests of the entire region, namely, the lower St. Maurice Valley.

Strip surveys were made on compass lines and were one-half chain wide and varied in length from 1 to 80 chains. All trees on the strips above 8 inches in diameter were calipered. At the end of every second chain a square-rod plot was marked out and the seedlings counted. All trees below breast height were classed as seedlings, without regard to age. The number of seedlings per acre was calculated on the basis of the square-rod plots. The ages of the previous cuttings were determined and the age of the seedlings in reference to the cuttings. The total area of the strips comprised 60 acres.

The author states that the primeval forests of the lower St. Maurice Valley were dominated by white pine, and from evidences of stump remains he believes there were considerably more than 5 mature trees per acre. Although white pine was dominant, it was far outnumbered by other species. The pine really formed an open upper story, with birch, maple, spruce, and balsam subordinate in a lower story. With the elimination of the upper story of white pine, the forest is no longer coniferous in aspect, but rather a typical "green" forest or one in which hardwoods are dominant. Although white-pine stumps are everywhere common, this species is not reproducing itself in any part of the forest. There are, however, abundant spruce and balsam between the dominant hardwoods, which in time will grow up through the hardwood crowns and change the forest from its present "green" form to a "black" one.

The author's studies show that, so far as numbers go, the reproduction of pulpwood species is sufficiently abundant to insure another pulpwood stand on these extensive cut-over lands, were it not for the extraordinary mortality after the seedlings become well started. This is shown in the following table:

Species	Seedlings (trees up to 1 in. diameter)	Saplings (1 in. to 4 in. diameter)	Poles (4 in. to 8 in. diameter)	Poles (8 in. to 12 in. diameter)	Total	Per cent
Spruce	635	99	30	6	770	14.8
Balsam	3,972	161	59	6	4,198	80.8
Cedar	180	32	8	..	.....	4.2
Hemlock	8	2	1	..	11	0.2

Unfortunately, numbers alone in reproduction studies are not criteria for future crops. The mortality rate must be considered. Thus, from the above table, it appears that in the spruce the 635 seedlings per acre, which include trees up to one inch in diameter, are reduced to 6 when the trees are 6 to 12 inches in diameter, while the 3,972 balsam are also reduced to 6.

In the author's opinion, each logging operation for softwoods so stimulates the growth of the hardwoods that the crowns of the dominant species fill all gaps in the canopy and stimulate the development of a more or less dense thicket of hardwood shrubbery on the forest floor. Both of these tend to suppress the spruce and balsam. He believes that the lessees of these cut-over timber limits, who are chiefly companies manufacturing paper pulp, cannot afford to hold them, where they are now dominated by hardwoods, for a second crop of spruce and balsam, because of the long length of time required and the probability of a yield of an average of three cords or less of pulpwood per acre. Were it possible to utilize the hardwoods without too much destruction of the young balsam and spruce, the problem would solve itself. As it is, however, if the dominant hardwoods cannot be eliminated there is little hope that the present pulpwood limits can be indefinitely held by the lessee with the expectation of a profitable yield of pulpwood later on. The author states that comprehensive studies and field experiments should be immediately undertaken to solve this most important problem of Canadian forestry, namely, the economic replacement of pulp species on cut-over pulp lands.

J. W. T.

Annual Progress Report upon State Forest Administration in South Australia for the Year 1916-1917. By W. Gill. Woods and Forests Department. Adelaide, S. A. 1917. Pp. 12. Plts. vi.

The one successful attempt at a forest policy among the Australian colonies was made by the almost forestless colony of South Australia, which in 1882 reserved some of its scanty forest area of 217,000 acres and started upon a systematic planting campaign.

The report of the Conservator, Mr. Gill, who is proud to add to his titles the Honorable Vice-Presidency of the Forestry Society of California, is that since 1911 some 20,000 acres were bought additionally for afforestation purposes, and the total area in reserve is stated as 148,529 acres.

The poverty of the native woods in this semi-arid country makes planting the main concern, and since the plantations must be fenced in against stock and game, 121,500 acres being so far fenced, the operation is extra expensive, and in the 41 years for which the accounts are tabulated the revenues have not yet recouped the expenditure, but especially the good showing which the year of the report exhibits permits the hope that receipts will soon balance expenditures.

In these 41 years the expenditures have been not quite two million dollars, while the receipts aggregate a little over one million.

Curiously enough, our *Pinus insignis*, the remarkable pine of California, a species which by its very confined range might be considered decadent, has been most successfully employed in the planting, yielding most satisfactory material for fruit boxes, filling a very important need. Since the first plantation became utilizable in 1903, nearly 600,000 cases, worth $100,000, have been cut. This pine in 33 years makes diameters 18 to 24 inches, with heights of 90 feet, and is ready for cutting for this use.

For the last 35 years free distribution of trees for private planting has taken place, and altogether nearly 10 million trees have been distributed to 50,000 persons.

We note in the expenditures an allowance of $8,000 for a school of forestry and a small allowance for investigative work.

B. E. F.

Effects of Grazing upon Western Yellow-pine Reproduction in the National Forests of Arizona and New Mexico. By R. R. Hill. U. S. Department of Agriculture, Forest Service. Bulletin 580. Washington, D. C. 1917.

For 30 years, or even longer, there has been a marked difference of opinion regarding the effect of grazing on the natural reproduction of yellow pine in Arizona and New Mexico. It is but natural that the users of the forest range should minimize the effects of grazing, while those engaged in the study of reproduction should deplore the damage directly or indirectly due to grazing.

The bulletin under review, written by a grazing examiner of the Forest Service, presents the results of a study to determine the character and extent of damage to yellow-pine reproduction in the Southwest from the grazing of live-stock in order to determine how to reduce such damage to a minimum while permitting the utilization of the forage.

An intensive study was made on the Coconino National Forest, where grazing and timber conditions are typical of the yellow-pine forests of the entire Southwest and where natural reproduction is uncertain and often difficult to attain. After a preliminary reconnaissance in 1910 a detailed study was made of 150 sample plots. In 1912 additional plots were studied. In all, 250 plots were studied in detail within 25 miles of Flagstaff, Arizona. The study of the sample plots was supplemented by general observations extending over a period of two years on other forests in Arizona and New Mexico. The plots were located so as to include the following range of conditions:

(1) Areas embracing all conditions of range normally grazed by different classes of stock.

(2) Areas embracing all conditions of range overgrazed by different classes of stock.

(3) Areas supporting a good stand of forage normally grazed by all classes of stock.

(4) Areas supporting a poor stand of forage normally grazed by all classes of stock.

(5) Areas supporting chiefly bunch grasses, grazed by different classes of stock.

(6) Areas where cattle congregate.

(7) Areas where sheep congregate—*i. e.*, along driveways and on bed grounds.

Studies made on these plots at requisite intervals showed that 42 per cent of the total number of trees observed are damaged to some extent annually, and that 16.7 per cent are subject to severe damage under the grazing conditions prevailing over at least one-half of the yellow-pine type on the Coconino Forest. The greater amount of damage occurred during the latter half of June and early in July and the least during the first few weeks of the grazing season. During periods most favorable for the growth of forage there is usually little damage. The pine shoots are succulent and tender prior to the middle of August and consequently are more palatable than later in the year. The damage in any year is practically confined to the growth of the year.

Although all classes of stock are likely to damage yellow-pine reproduction, it is believed by the writer that horses and burros may be eliminated from the classes of stock responsible for severe damage. Although damage by cattle is everywhere apparent, the greatest damage is done by sheep, as set forth in a table showing a comparison of cattle and sheep damage. Sheep are found to do approximately 7½ times as much damage as cattle.

The data collected from these interesting reproduction studies show that yellow-pine reproduction is not eaten by stock through preference when palatable forage is available, but when palatable forage is not sufficient for the classes of stock on the range, which is often the case, yellow-pine reproduction is likely to be seriously damaged.

The author believes that the results of his study on the Coconino Forest are applicable over the entire yellow-pine type in the Southwest. He states that under present conditions all yellow-pine reproduction should be protected against serious damage by grazing. Overgrazing should be avoided. Sheep should be expelled from cutting areas on which they are causing severe damage until reproduction is well established.

The evidence presented by the author, in the reviewer's opinion, clearly proves the enormous damage done to yellow-pine reproduction by cattle and sheep. Unfortunately the means for overcoming this damage is mostly set forth in generalizations which are of little value in solving one of the most important silvicultural problems with which the National Forest Service has to deal, namely, regeneration of western yellow pine in the Southwest. Some day the "bull will be taken by the horns" and the necessity for areas closed to grazing during the period of regeneration will be more fully appreciated than at present.

J. W. T.

Report of the Minister of Lands and Forests of the Province of Quebec for the Twelve Months Ended June 30, 1917. Quebec, Que. 1917. Pp. 133.

The perusal of the portion of this report headed "Woods and Forests" (on 45 pages) impresses one with the fact that in the ninth year of its existence the forest service is still rather carrying on a timber-land administration than practicing forestry. We should, however, be satisfied with the fact that in Quebec this timber-land administration is at least under the direction of technical men, while in the large sister province, Ontario, a careful avoidance of such logical arrangement is to be noted.

Mr. Piché, Chief of the Forestry Service, in very simple language, recites the accomplishments as well as the hopes.

Among the accomplishments stands first of all the collection of a revenue amounting to $1,568,157 in ground rents, stumpage dues, bonuses, etc. But the report foreshadows a reduction in 1917-1918 to not exceeding one million dollars, due to lack of labor and other disturbances caused by the war, which are reducing the cut. Closer utilization, due to closer inspection, is noted; "the proportion of waste continuously decreases to a remarkable extent." Closer inspection also reduces illegal cutting. The forest service is also engaged in land classification, township by township, to segregate the lands fit for agricultural settlement.

In spite of war conditions, additional timber limits were auctioned off to the extent of 877 square miles at a price of $415,615, the bonus per square mile exceeding by more than $200 the price obtained in 1914.

A longer discussion of the pulpwood situation brings out the fact that from 1908 to 1916 the consumption of pulpwood by Canadian mills has continuously increased to more than 260 per cent in amount and in value more than 340 per cent, the province of Quebec furnishing more than one-half the woodpulp produced in the Dominion. Of the 1,068,-000 cords of pulpwood exported in 1916, 706,879 cords, or 74 per cent, came from Quebec, and as the export from crown lands is prohibited, this export came from private lands. Private lands also contributed about two-thirds of the total sawlog cut of 1,265 million feet, the total wood cut being valued at $27,500,000.[1]

As regards reforestation, the planting work of several paper companies is referred to. The attitude of the government is expressed as follows:

"Reforesting the timber limits is a very delicate matter to deal with, and we are now considering how we might arrange the matter with the license-holders without binding our successors more than we have the right to do. The question will be to decide whether the work should be done by the government or by the license-holders or by both jointly and what compensation should be allowed the licensees for their share in the improvement. So long as the fire problem was not solved, the question had to be neglected; but now that we are sure of success, we must see as soon as possible to restoring forests on areas devastated by fire or impoverished by exhausting farming methods."

To assist in the reforestation work, the government nursery at Berthierville is to have its capacity increased to 2.5 million plants for sale to would-be planters.

The government itself so far has made only some sand-dune plantings on a small scale.

A series of technical studies and explorations are gradually being developed.

The protection against fire being still not a function of the forest service, a separate appendix brings on three pages the report of the Superintendent of the Forest Protection Branch, briefly giving the statistics of the year, from which it appears that 243 square miles were burned.

B. E. F.

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[1] These and other statistics in detail may also be found in the handsomely printed *Statistical Yearbook of Quebec, 1917*, to which Mr. Piché contributes an article on chemical pulp, which in the pulp production of the Dominion is now represented by 35 per cent of the total.

Canadian Bark-beetles. By J. M. Swaine, Canadian Department of Agriculture. Bulletin 14. Pp. 32. 1917.

The Canadian Division of Entomology has been quite active in the study of the forest-insect problem of the Dominion. Inasmuch as in a number of important cases the Canadian infestations are similar to our own, American foresters should be interested in the work Mr. Swaine is doing in Canada in forest-insect protection.

The Dominion Entomologist prefaces Mr. Swaine's bulletin with the following brief statement of the importance and status of the forest-insect problems in Canada:

"The bark-beetles constitute the chief insect enemies of our coniferous forests, and it is impossible to give even an approximate estimate of the enormous annual loss caused by their depredations throughout Canada. Much of the dead timber whose destruction is attributed to fire is the result of outbreaks of bark-beetles; this is particularly true in British Columbia. In consequence of their great economic importance, Mr. Swaine has been devoting the greater part of his attention for a number of years to a study of the species of bark-beetles, their life histories and bionomics. We are now in a position to commence the publication of the practical and scientific results of these investigations, and it is proposed to issue them in a short series of bulletins, of which the present is the first part."

In his bulletin Mr. Swaine describes about fifty new species of bark-beetles, a number of which have been found to occur in various parts of the United States.

A few years ago, under the same authorship, "Forest Insect Conditions in British Columbia" was published by the Canadian Department of Agriculture (Entomological Bulletin Number 7). Foresters in the Rocky Mountain and Pacific Coast region will find this publication of considerable value, especially since the insect enemies of western yellow pine, western white pine, Douglas fir, lodgepole pine, and Sitka spruce discussed for British Columbia are identical with the one with which American foresters are concerned. The description of control methods and the underlying economic considerations make this publication doubly valuable.

A. J. JAENICKE.

Report of the Director of Forestry for the Year 1917. (Part VI, Annual Report, Department of the Interior.) By R. H. Campbell. Ottawa, Canada. 1918. Pp. 81.

Although by enlistments the Forestry Branch lost 65 of its employees of all ranks, 36 of its permanent staff of 205, the activities of the Service were all more or less continued. Mr. R. H. Campbell, the Director, summarizes these activities on 26 pages, the details being found in six separate reports by officers in charge. These activities cover the administration of the 23 million acres of forest reserves, organized in four districts—fire protection, planting and nurseries, surveys, forest products investigations, and gathering of statistics. The generous (for the time) appropriation of $750,000 was not all spent; a mathematical comparison brings the expenditure to a little over 3 cents per acre, while the income is almost nominal, less the $43,000, which is due to the sorry fact that the timber licenses covering the reservations before they were established are not under the administration of the Forest Service.

From the statistical part we learn that the war did not much reduce the total cut and value of forest products in the Dominion, their value in 1916 amounting to $172,830,000, the falling off in lumber ($66,075,-000) being compensated for by an increase in pulpwood ($19,975,000) and ties. It is interesting to note that fuelwood ($62,000,000) was valued at almost the same amount as lumber, lath, and shingles.

The exploratory surveys, which are carried on to find the areas that ought to be kept as forest reserves, if continued in the same way as hitherto, will be finished in three or four years; their average cost has been 60 cents per square mile.

Reforestation was begun on one of the reserves in the prairie districts to a more than experimental extent, namely, 27 acres, besides experimental planting of four acres, each in half-acre plots, in three other reserves, Scotch pine, jack pine, white spruce, and caragana being used, seedlings and transplants, the larger plantation costing $9.93 per acre for seedlings and $20.75 for transplants—a rather expensive performance with home-grown material in a spacing of four by four. The two main nurseries, containing over 9,000,000 plants of species fit for use mainly in shelterwood planting (seedlings and cuttings of maple, ash, caragana, willow, Russian poplar, and a small number of transplants of Scotch, jack and lodgepole pines, and white spruce), distributed nearly that number to 4,627 applicants, free of charge, so that an average of 1,684 plants to the applicant was attained. This planting is followed up by nine inspectors, making sure that instructions are followed. This department has nearly trebled in number of plants distributed in the last five years and is undoubtedly effective.

The administrative reports of the district inspectors show especially progress in perfecting accessibility by roads and trails and fire protection by lookouts and telephones and organization of patrols. Due to favorable weather and also as a result of a publicity campaign, the fire losses were unusually small. Brush disposal has become a regular condition in timber permits and with satisfactory results, and other measures for improvement in logging operations seem to find gradual entrance.

The work of the Forest Products Laboratories has, of course, also been hampered by reduction of staff due to war conditions. It is carried on in four divisions, namely, timber physics, timber tests, wood preservation, and pulp and paper. Perhaps the most ambitious work, which has just come from the press and which will be reviewed separately, is the study of *Canadian Douglas Fir.*

B. E. F.

Forests and Chihli Floods. By D. Y. Lin, Nanking, China. Pp. 13. 1918.

The remarkable progress in forestry propaganda in China in recent years indicates better things for Chinese forestry in the near future. This is an encouraging outlook, as there is no other considerable area of the earth where the organization and development of public and private forestry is so much needed. Mr. Lin has already proved himself a past master in arousing his countrymen to the great economic need of forests in the various Chinese provinces. Through his untiring efforts as a lecturer, as a teacher, and as a publicist, forestry is rapidly becoming known in China. He has recently organized the Chinese Forestry Association and has been a leader in Arbor Day activities. In December, 1917, he made an investigation of the vast flooded area about Tientsin. This flood of late last year completely ruined or caused more or less damage to 17,646 villages. There were more than five and a half million sufferers from the flood, most of whom were rendered homeless by it.

The pamphlet under review is an English translation by the author of his pamphlet in Chinese, published in a large edition for wide distribution in China. Mr. Lin in his plea for control of floods by extensive afforestation quotes many engineers and scientists working in China in support of his contention that afforestation on an extensive scale is necessary to arrest the present vast amount of ruin and damage from periodic floods.

It appears that the damage is largely due to the vast amount of silt brought down from the denuded uplands. The silt fills the stream beds, thus reducing their capacity for carrying water. As a result, embankments are broken and the adjacent country flooded.

The following quotation from Mr. H. Vander Veen, C. E., for many years consulting engineer in Peking, indicates the necessity for the elimination of the present load of silt in the streams if damage from floods is to be reduced:

"As long as the slope of the water level is such that a current can be maintained strong enough to carry all the matter held in suspension along, no harm is done. But the natural slope of the plain is, for several rivers, insufficient. In such a case the river is therefore forced to get rid of the soil held in suspension along its way; consequently its bed gets raised, and in the long run the river has to find another course, which it does by bursting its dikes to find in the lower lying land the place where it can deposit its burden, which it could carry no longer and for which no more room could be found in the old bed. This is the case more or less with every river running through the plain of China.

"The only way to diminish this evil is to diminish the amount of soil brought down from the mountains. And the reason for this enormous quantity of silt coming down from the mountains is that those mountains are bare, so that during a heavy rain nothing prevents the water from rushing downward practically immediately after it has fallen, taking with it large quantities of soil, so that it reaches the river down below more like torrents of mud than of water. Now, if those mountains were planted with trees, not only would the water then be unable to take away so much soil, but it would also reach the river graudally, in a regular flow, divided over a longer period, and not within a few hours, in fierce torrents.

"It is impossible to lay too much stress upon the enormous importance of afforestation. The deterioration of the various rivers in China would never have reached its present stage if deforestation had not taken place."

The author discusses the effects of forests on floods under the following heads:

Forests and streamflow.

Forests and soil erosion.

Forests and floods.

He concludes that the problem of flood control in China is fundamentally a forest problem, because afforestation is the only way by which the present load of silt can be permanently kept from the watercourses.

J. W. T.

Silviculture for Country Roadsides. By R. T. Fisher. Forestry Association, Bulletin 123. 1918.

Americans are everywhere, outside of our cities, extravagant in the use of land. Idle land, even in the earlier settled parts of the country, is often as great in extent as that put to economic use. In the aggregate the right of way for country highways occupies a vast acreage, of which the actual roadbed is but a small part. In most European countries the land is utilized to the very edge of the roadbed, but in this country there is a strip of unused land at either side extending to the boundary of the right of way. These strips of unused land are commonly about one and a half rods wide and require considerable attention on the part of highway commissioners and local tree wardens to keep them free from weeds and brush. Periodic "brushing out" of these strips of idle land can only be done at considerable cost, which the author considers a waste of money, as the improvement is only temporary. He believes that forest trees should be planted or encouraged from natural regeneration, as this silvicultural treatment is the only practical way to keep the right of way free from woods and brush. The trees should be free of lower branches in order to attain air circulation across the roadbed and permit an unobstructed view on either side over the adjacent country. The roadbed is shaded in summer and less dusty than one exposed to full sunlight. The snow is prevented from drifting over the roadbed in winter, and when the crowns are sufficiently high and without lower branches the roadbed is overwet only on exceptional sites.

The author describes a practical method for developing roadside forests and gives lists of species most useful on different sites in New England. The bulletin is illustrated by photographs showing roadbeds bordered by weeds and brush which require frequent attention and others bordered by stands of timber of suitable character to keep the roadbed in good condition.

J. W. T.

Variation in the Chemical Composition of Soils. By W. O. Robinson, L. A. Steinkoenig, and William H. Fry. U. S. Department of Agriculture, Bureau of Soils, Bulletin 551, Washington, D. C. 1917.

The purpose of this paper is to show the magnitude of variation in the chemical composition of American soils. The data are from a previous paper giving the complete analysis of a number of important American soils supplemented by the analysis of 45 samples representing 18 distinct soil types given for the first time in the present paper.

The paper discusses the preparation of samples and gives the methods and results of analysis. There is also presented a discussion of the data in which special consideration is given to the relation of soil to subsoil and to the extreme variations in major constituents in different soils, and even in soils of the same type.

J. W. T.

Systematic Investigations of Tropical American Plants. Contributions from the United States National Herbarium, Vol. 18, 1914-1917. Washington, D. C. Pp. 494.

Contains articles by W. E. Sanford on Annonaceæ; by H. Pittier, dealing principally with Columbian and Central American trees and other plants; by P. C. Standley on certain Panama plants, and by A. S. Hitchcock on West Indian grass flora.

RECENT PUBLICATIONS

WOODWORKER, XXXVI, February, 1918—

Rip-saw Accidents and Their Prevention. Pp. 31-33.

A description of accidents that often occur in using circular rip-saws, and the manner in which such accidents can be readily avoided. Foresters engaged in studies in wood utilization and technology where the use of such saws is demanded will find this article of much interest.

Making the Airplane Propeller. Pp. 26.

A description of the methods of building up, turning, finishing, and balancing airplane propellers.

ENGINEERING AND CONTRACTING, XLIX, February 20, 1918—

Method of Burning Fat Pine Stumps in Place. Pp. 186.

Land Clearing with Donkey and Traction Engines. Pp. 191.

SAFETY ENGINEERING, XXXV, January, 1918—

Steel or Iron Supports Not Always the Best. Pp. 24.

Photographs of the ruins of the sawmill of the Alberta Lumber Company, of Vancouver, B. C., and a discussion of the relative safety of steel, iron, and timber supports.

COMMERCIAL AMERICA, XIV, January, 1918—

The Making of a Whip. M. E. Thompson.

Methods employed in whip manufacturing; woods used, and relative value of different woods.

AMERICAN INDUSTRIES SUPPLEMENT, January, 1918—

Safety in Lumbering.

A description of nine safety appliances recommended by the Committee of Health and Safety of the National Association of Manufacturers.

PERIODICAL LITERATURE

BOTANY AND ZOOLOGY

Action of Schumann Rays on Living Organisms

Light of shorter wave-lengths acts more rapidly and strongly on protoplasm than does light of longer wave-lengths. The Schumann rays lie in the ultra-violet regions of the spectrum and have wave-lengths of from 2,000 to 1,250 Engström units. The light in this region of the spectrum is much more injurious to protoplasm than is the light of longer wave-lengths, according to Bovie.

A large part of the article is devoted to history and technique. The action upon various organisms is discussed fully.

Botanical Gazette, Vol. LXI, No. 1, January, 1916, pp. 1-27.

SOIL, WATER, AND CLIMATE

Peat Soil Qualities

Under the drainage law of the State of Wisconsin, Dunnewald has examined an area of about 6,600 acres of marshes and swamps to find out whether a favorable or unfavorable condition would be found in different areas and whether the vegetation would, as claimed by practical farmers, give an indication of such conditions, such claim declaring black spruce or moss-covered swamps not good for cropping. The author considers his experiments to confirm the farmers' statements that trees, such as ash, elm, birch, white pine, show a better quality of peat than that on which grow only black spruce or tamarack, sphagnum moss, blueberries, and cassandra, and that peat bearing black spruce and tamarack has 20 per cent less mineral matter and a much higher degree of acidity and somewhat less nitrogen.

Vegetation on Swamps and Marshes as an Indicator of the Quality of Peat Soil. Journal of American Society of Agronomy, October, 1917, pp. 322-324.

Bogs

Rigg brings together the theories and findings of the leading authorities. The following subjects are discussed:

1. Xerophily of bog plants.
2. Why are plants characteristic of bogs mainly xerophytic?

3. How are plants other than bog xerophytes inhibited from bogs?
4. What are the possible sources of toxic substances in bog water?
5. How do toxic substances in bog water act on plants?

A Summary of Bog Theories. Plant World, vol. 9, No. 10, October, 1916.

Soil Aëration

Cannon and Free worked independently, the former at the Desert Laboratory, Tucson, Arizona, and the latter at the Coastal Laboratory, Carmel, Cal.

Different plant roots behave differently with respect to effect of composition of soil atmosphere. Pure carbon dioxide inhibits growth of both Prosopis and Opuntia, but Prosopis stands more carbon dioxide and can get along with less oxygen than Opuntia. Salix was grown entirely without oxygen for 10 weeks without injurious results.

The presence of living matter in the soil, such as bacteria, protozoa, and fungi, tends to lower the oxygen content and raise the Co_2 content as compared with the general atmosphere. This tendency is counteracted by diffusion between soil and general atmosphere, but the action is slow.

The authors think the composition of soil atmosphere is an important factor in determining the distribution of plants. Cacti do not grow well in soils heavily charged with Co_2. The distribution of Prosopis, Nercium, and Salix indicates that the presence of large amounts of Co_2 is not a limiting factor with them.

Soil aëration is believed to play an important part in zonation in the central flats, or "playas," in basins of the semi-arid regions. The flats are usually composed of fine soils and are poorly aërated. The vegetation in such flats is often limited or wanting, and around the flats, or "playas," it is arranged in well-defined zones. This arrangement is believed in many instances due not to differences in moisture, but differences in soil aëration.

The Ecological Significance of Soil Eëration. Science, February 23, 1917.

SILVICULTURE, PROTECTION, AND EXTENSION

An Oak Parasite

Moreillon gives an account of damage done to old oak trees in the foothills of the Jura Mountains by a fungus, *Diaporta taleola* Tul., which causes droppings of branchlets and twigs, like the noted droppings of Norway spruce and other species. The droppings take place in the latter half of September and are detached at the base of some annual shoot up to ten years old. One can count sometimes ten branchlets to the square yard, and it is calculated that about 1 per cent of the foliage twigs is thus prematurely lost.

The infection takes place in summer on the unlignified shoot. The mycelium enters the corky and surface layers of the wood, interfering with the water supply, turns the color of the wood brown, dries it out, and finally kills the twigs and gives a stagheaded appearance to the tree. It attacks oaks from 50 to 150 years on all sites and reduces at least their increment. It is suggested that it also prepares the field for insect development. No remedy is known.

Dégâts causés aux chênes par le champignon Diaporta taleola Tul. Journal Forestier Suisse, January, 1918, pp. 1–3.

Spruce Management in France

In connection with the essay on fir forest management, by Gazin, printed in a previous issue of the present volume of the JOURNAL, it is of interest to brief the discussion on the silviculture of Norway spruce in association with fir in the same mountains (Vosges) by E. Mer. Naturally this spruce occurs here generally only above the altitudinal limit of fir (3,000 to 3,500 feet), with the exception of certain specially humid valleys; centenarians are here found covering the summits of mountains up to 4,000 feet, mixed with undersized fir and broadleaf species, beech, maple, sycamore, mountain ash, etc., which also constitute the scrubby timberline forest. Elsewhere the spruce was only artificially introduced 60 to 75 years ago and a few older stands by planting or sowing on old pastures, mostly in pure stands. Mer discusses the experiences with such plantations on one of the national forests of which he became charged in 1875. Sowing in furrows across the slopes, which had been the practice, brought about an uneven distribution of seed, so that the sowing was too dense in spots, too open in other spots, and hence of very uneven growth in crowded and open stands, mostly of small diameter, 3 to 4 inches, with small crowns, only here and there of double the dimensions. A variety of soil and exposure produced, of course, also varied results, north slopes and deep soils showing the better development than thin soils and south aspects. In occasional depressions, where water could collect, a very satisfactory increment had taken place, especially in height, due to the fact that here dominant growth developed and the subdominant had spontaneously disappeared by wind, snow, or shading, or else having been cut. This suggests that by timely thinning the other stands might also have improved in growth, beginning in the 15th to 20th year by freeing a final harvest crop, repeating the operation two or three times until the 20th year. Mer did begin thinnings in 1886, somewhat later than desirable, leaving the stoutest and the promising of the next class as possible substitutes for final harvest crop, spacing them, as far as possible, evenly; also pruning dead branches of the trees of the first category.

By appropriate measuring on sample plots the increment was determined by cutting and analyzing after a few years. The dominant class showed some increased growth in diameter, but the second class had practically stood still; the operation had benefited only the most vigorous specimens. The thinning, to be sure, was not severe, and the time allowed for recovering was probably too short; the crown had not had time to lengthen and on some trees had in part died.

The second thinning, made 10 years later, was made severe, giving a position to the final harvest crop so that branches did not touch. The effect was not better, showing the inability of the spruce to recover; the remedy came too late.

Another series of thinnings on a planted 20 to 25 year stand showed that volume and money can be made by timely thinning, having produced in 20 years after the thinning at the rate of 57 cubic feet and $114 per acre more than the unthinned area.

The author scores at length the foolhardiness of planting in large operations a species where it does not occur naturally, in pure stands, and which in its native habitat in the higher altitudes is so liable to wind and snow breakages, with its sequel of bark beetles and rot. He also discusses the possible management for regeneration of the fir forests.

From his experiences, the author is inclined to recommend planting instead of sowing, mixing with fir, using 4 to 5 year-old spruces, setting them 12 feet spaced, and when 15 to 20 years old setting out one fir plant, 5 to 6 years old, between each two spruces, so that there will be about 1,000 plants to the acre.

The author enumerates nine advantages of this mixture and the use of the spruce generally, namely, reduction of damage by wind and snow; surer natural regeneration; better soil protection; better production, since the spruce is a more rapid grower and brings the same price as fir, being of similar quality; frost resistance of the spruce superior to fir; ability of spruce to thrive in the open, from the standpoint of light requirement mutually advantageous. Objections to the spruce are not overlooked. It suffers from fungous diseases in wood and foliage and from bark beetles, but the author thinks by proper treatment these can be avoided, especially by timely thinnings, and, in the nursery, by wide spacing of transplants, etc.

In conclusion, while the author wants the fir to remain the leading species in the Vosges Mountains, the spruce is to be introduced in the larger openings whose soil is somewhat deteriorated.

Association de l'Épicéa au Sapin. Revue des Eaux et Forêts, September-December, 1917, pp. 262-270, 289-295, 321-325, 353-359.

Artificial vs. Natural Regeneration

A report by Milward, of the Indian Forest Service, on teak management in Java is of interest to us mainly for the discussion on methods of propagation. It appears that the proper silviculture of this most important Indian tree species "to the Indian forester still continues to be the question of questions and as far from finality as ever before." In British India there are at least four distinct methods used: that of plantation, pure and simple; the taungya system, in combination with farm use and gradual planting by annual addition of saplings; natural reproduction, which "involves an enormous expenditure of labor and money, but the results are often of merely temporary benefit, thus producing a minimum effect with a maximum outlay"; lastly, coppicing.

The Dutch Government have almost from the very outset come to the definite conclusion that the management of natural teak forests is not only difficult and expensive, but is on the whole uncertain; they have, therefore, substituted a wholesale system of planting, some 84,000 acres having been planted in Java. Interplanting with leguminous crop (*Leucæna glauca*), which keeps weeds down and enriches the soil, is also practiced.

Teak in Java. Indian Forester, October, 1917, pp. 467-470.

Scotch Pine in Pennsylvania

In a well illustrated article Professor Illick attempts to justify the use of Scotch pine in the extensive plantings of the Pennsylvania Forest Service. Of the twenty-odd million trees which the department has set out in the last eight or nine years, mainly seven species were used, and among them three Europeans—Scotch pine, Norway spruce, and larch. While white pine represents over 70 per cent in the plantations, Norway spruce represented nearly 14 per cent and Scotch pine half that percentage, with 1,354,734 trees, in increasing numbers until, in 1916, around 715,000 were set out of that species. The wide range of the species in Europe and Asia—from southern Spain to Norway and northern Sweden, east to Lapland, Siberia along the Arctic circle to the Amur and south to Persia—promises ready climatic adaptation, provided seeds are derived from the proper locality. Reference is made to experiments to determine whether crookedness and other local characteristics are inherited and repeat themselves; the question is left, however, somewhat in doubt, Mayr being cited as opposing the theory of inheritance, while Eberswalde experiments support the now generally accepted theory that the characteristics of growth exhibited in a given region propagate themselves. Eastern Prussia and the Riga district of Russia are referred to as producing straight trees.

Interesting measurements on the height growth in a plantation of 34,000 trees reveal for the first ten years a remarkable increment; a moderate increase of current height growth for the first five years, at the rate of 6.4 inches in the fifth year, then a sudden change to over one foot, and finally in the eleventh year with 32 inches, bringing the total height to 13.5 feet. This is the average, while exceptional specimens grew 52 inches in the season and the ten tallest trees averaged as much as 22 feet at 11 years. A white-pine plantation in the same time had averaged only 9.2 feet and the Norway spruce only 5.9 feet, although eventually it will outgrow the pines. For older stands, European experience is adduced, Schwappach's yield table being cited, which for site I gives at 10 years the average height as 12 feet, with diameter of 1.5 inches and with 1,696 trees a volume of 800 cubic feet, while at 100 years the figures are $h = 103$ feet; $d = 14$ inches; $n = 170$; $v = 13,470$.

The frugality of the species as to soil and climatic factors is praised as well as the ease of its propagation. Reference is made to a stand produced by the taungya system, planting 10,000 pines per acre in rows 3.3 feet apart, at intervals of 1.3 feet in the rows, and growing between the rows for three seasons potatoes, clearing in this period $20 per acre and the plantation without cost. The usual method in Germany is to plant one or two year-olds; sometimes seeding in plots. Cone sowings have produced many of the older stands. Mixing with spruce and underplanting with beech is done to prevent soil deterioration. Natural regeneration, which on account of its light requirements had been often a failure, is lately coming into use again, especially in the strip system.

The author concludes that "there seems no special need for planting (this pine) extensively in Pennsylvania for forestry purposes." Many of the native pines produce equal or superior wood, reach a larger size, continue their growth for a longer period, and, with some experience, can be handled as successfully. It may, however, be advisable to continue the planting of it until we understand the silvical requirements and preferences of the native pines better, especially upon sites with adverse growth conditions, such as extremely sandy areas and windswept slopes and plateaus, upon which this soil-modest and windfirm species is known to grow satisfactorily. It may also be recommended for planting upon areas occupied by scrub oak and other inferior forest growth, for its aggressive habit during youth fits it particularly to overcome this type of almost worthless growth, which is very common and covers extensive areas in Pennsylvania.

Forest Leaves, December, 1917, pp. 87-90.

French Forest Recuperation

An "old practitioner" enlarges on the French forests which have *not* been within the war zone, but have been cut for war materials and which, in spite of faulty exploitation, may recover in a short time. Admitting such faulty treatment that could have been avoided, the author goes so far as to claim that the abandonment of the spirit of economy, which was charged against the forest service before the war, has been in some cases a benefit, by opening middle-aged stands of oak and beech mixed, which should have been thinned to favor the oak and to give light for its regeneration, so that to satisfy the army requirements has often meant only anticipation of the regular cut. But thieveries of fuelwood have done much damage in the coppice stands, while, on the other hand, poaching and illegal hunting by the military has reduced game so as to diminish sensibly the damage it is responsible for.

In the pineries it is different. Here clear cutting has been practiced in larger or smaller fellings, and natural regeneration is not to be relied upon. Here, as before, replanting becomes necessary. In this case, too, the reduction of game has been an advantage. In this replanting the author admits for conifers only Scotch and Maritime pine, to be grown in "flying" nurseries, which require the least attention and cost.

Planting stock of birch (white) can be secured directly from the forest. Of other broadleaf species the author favors the chestnut, wherever climate and soil are satisfactory, and oak, both of which he grows in permanent nursery, transplanting yearlings and using the transplants after two years in bed. They are planted in about 3 by 5 feet spacing in furrows and do not need replacement unless more than 25 per cent fail. In five years such a plantation is established, and in ten years the oak and chestnut need to be freed from the birch, which is then fit for broom handles.

For pine plantations the author mixes the two pines, because the more rapid *maritima* is not surely frost-proof; hence in case of its failure the *silvestris* will at least survive. Although even sowings in furrows and spots have been sufficiently successful, the author favors for the highly siliceous sand and gravel soils planting with ball, using a circular spade. For this purpose the planting stock must, of course, be grown on a sufficiently compact (clay or humous) soil, so as to keep the ball from breaking down in transportation. This is done on strips 1 yard wide and 1.5 yards left blank between, on which the surface débris of the prepared strips (by hoe) may be raked. He uses as much as 60 pounds per acre of Scotch pine seed and double the quantity for the *maritima*. On better soils this could be reduced. From such sowing 60,000 *silvestris* and 80,000 *maritima* plants can be secured, besides leaving enough to reforest the strip. Almost the entire output of the *maritima* is utilizable, while in the *silvestris* selection is necessary. The age at which the plants may be transplanted ranges from two years to four years; exceptionally *silvestris* may be used up to six years; if planted in mixture, four-year-old Scotch with two-year-old *maritima* should be used. They are then set out, spaced 1 by 1.5 yards, which makes complete crown cover in about 12 years.

Notes d'un vieux Praticien. Revue des Eaux et Forêts, December, 1917, pp. 360-368.

Black Locust to the Front

The appearance of a volume of 263 pages (*Le Robinier pseudacacia*), by G. Vaulot, in 1914, gives occasion to Jolyet to sing the praises of this species, especially for reforestation of the devastated French and Belgian forests. Ease of propagation, cheapness of seed or plants, and high germinative power, drouth resistance, rapid growth, and superior wood quality combine to make the species desirable. That it is a tree of small dimensions does not seem to detract from the author's appreciation. Frost hardiness is, however, doubtful and is discussed at length. It is admitted that the southern climate of France is more congenial to the species, but the author thinks it will thrive in the north also, escaping the late spring frosts by its tardy leafing and finding there warm summers, which ripen the wood in time before fall frosts. The existence of specimens in southern Norway and at altitudes of over 2,400 feet in northern Hungary are assuring. For calcareous soils, however, which abound in the war zone, it is not suitable, but the shrapnel holes in the Tertiary formation will be useful if immediately planted with locust for rapid wood production in mixture with sycamore or with Austrian pine. The method proposed is to dig holes, 8-inch cube, in the fall, filling the earth back in May, and sowing the seed mixed with oats or barley, the reason for which latter addition is not stated.

Revue des Eaux et Forêts, September, 1917, pp. 257-261.

Blister Rust on Ribes Wood

Gravatt and Colley have made the disturbing discovery, by experiment and otherwise, that uredinia of *Cronartium ribicola* develop on the *stems* of *Ribes hirtellum*. This discovery complicates the already difficult problem of detecting the disease on Ribes, since, even when defoliated, the disease may exist. Moreover, it is strong evidence that the disease can winter over on Ribes.

Science, XLVI, 1917, pp. 314-315.

Alpine Silviculture

Dr. Fankhauser recites the troubles which have been experienced in Switzerland in reforestation of alpine situations and proposes quite revolutionary proceeding.

When, some 40 years ago, the Swiss government began the establishment of protective forest on absolute forest soil in the high Alps, there was no experience to base the procedure on. Setting out stout transplants, which in the plain and hill country had been most successful, seemed to be the right thing. The first trouble was that the plants, being grown in nurseries at lower altitudes, were ready for planting before the planting ground was free from snow. Lifting the plants in the fall and heeling in near the planting ground spoiled the plants, due to the snow fungus (*Herpotrichia nigra*) and snow pressure. Lifting in spring and heeling in under snow dried out the roots. Heeling in the ground as it thawed necessitated the repetition of the process several times before they reached the planting ground, with consequent losses.

Establishing nurseries at higher altitudes brought other troubles, among which were damage from heaving; difficulty and expense in tending the nursery away from habitations; length of time to grow sufficiently stout plants; four years in transplant bed instead of two; greater expense; lack of suitable nursery ground; difficulty of transport and of planting itself in the difficult situations; expense of planting ($50 to $60 and even $80 per acre).

To reduce these difficulties the use of seedlings untransplanted, as practiced in the French Alps, was suggested, but rarely done. A number of such successful plantations is cited. But now the author advocates the use of *seeding in situ, especially on grassy areas!*

The use of seeding, which no practitioner thinks of now, was in olden times the common practice in reforesting, and a few stands secured in that way can still be seen in lower altitudes; but the author does not see any reason why it should not be successfully done in higher elevations, since Nature sows up to timberline, especially in grassy situations, the grass acting as a protection against heaving, snow pressure, eroding of soil, heating and drying, the dangers invited by sowing in bare soil. The fears that the grass would overgrow and suppress the seedlings is unwarranted. Professor Engler agrees to the favorable influence of grass cover in alpine situations. The woody plants finish their height growth before the damaging influence of the grass makes itself felt.

A few trial sowings were started in 1908 and with success; larger sowings were attempted, until in 1916 over 800 pounds of seed had been used in one district alone, a few trials being made in other districts.

The main point in the procedure is to disturb the grass cover as little as possible; even an opening as large as a hand is of the evil. What the author calls a pinch sowing (*Prisensaat*) consists in making a narrow rill of finger length by means of a small two-tined rake and introducing a small pinch of seed. The more hidden in the grass this rill the more perfect the result. For larger seed a hole may be made *horizontally* with a dibble, into which with a small spoon introducing the seed, closing the hole with the foot. If longer rills are made, they should follow the steepest grade as protection against the "creeping snow."

Judging from a given case, 2.5 pounds of seed per acre, producing, if only 2 per cent come up, 4,000 plants per acre, are sufficient, costing, say, $2 per acre.

Objections to this method are slow and circumstantial execution and too many plants in bunches. Hence it is proposed to use broadcast seeding, best done in the fall, and since, then, often the new seed crop might not be available, sowing on the first loose snow, which insures the washing of the seed into suitable interstices of the grass cover.

Where naked soil is to be reforested, the use of plants with ball taken from the grass sowings is recommended as sure and cheap.

Die Notwendigkeit einer Umgestaltung unseres Aufforstungsverfahrens im Gebirge. Schweizerische Zeitschrift für Forstwesen. January, February, 1918, pp. 1-8, 25-34.

MENSURATION, FINANCE, AND MANAGEMENT

Bamboo Increment

Osmaston, of the Indian Forest Service, reports a series of very careful and detailed measurements of the rate in height growth of bamboo on 17 specimens, measuring at six in the morning and six in the evening. The young culms appeared early in August and height growth was completed by end of November. Growth at first was very slow, rising gradually for 4 to 6 weeks until about 12 feet high, when the maximum rate was attained (relative humidity then being greatest) and maintained for several weeks, then gradually declining until growth ceased in November. It was found that the culms started, contrary to other observers, toward the middle of the rainy season and grew until two months or so after that season ended. The growth at night was mostly found near double that of the daytime. Thirteen inches in 24 hours was the most rapid growth; this culm reached full height (71 feet) in 3½ months. The total daily growth of one specimen measured from day to day was as follows: 40, 34, 52, 56, 78, 48, 72, 82, 78, 92, 64, 102, 108 hundredths of an inch—about 9 feet in 9 days.

Indian Forester, February, 1918, pp. 52-57.

White Spruce in Minnesota

W. H. Kenety, of the Forest Experiment Station at Cloquet, Minn., publishes an interesting report on his findings regarding the growth of white spruce, and urges its use as an investment for pulp and paper companies for the following reasons:

"What investment," he asks, "would be necessary to establish a plantation large enough to supply a mill using 25,000 cords of pulpwood annually, the first cut, other than thinnings, to be made in 50 years?

"The data collected show that 50 cords per acre is a probable yield at the end of 50 years on the proper type of soil. The cut from 500 acres would be required to supply the raw material for a year. Therefor, 25,000 acres must be planted if a series is to be established that will supply the mill indefinitely.

"This would entail the cutting of 500 acres and the planting of 500 acres after the first cut. In the start, it would be advisable to plant the tract in the first 25 years, if it were all purchased at one time.

"It would probably be impossible to purchase 500 acres each year contiguous to the land previously purchased, so it would be necessary to purchase all or a greater part of the 25,000 acres at the start. This is a little over a township, and when bought in such a large quantity should not cost over $5 per acre at the present time, deducting the value of the timber and young growth generally found on such land.

"The cost of raising a cord of pulpwood on a 55-year rotation, figuring 50 cords to the acre at the end of 50 years, would be $2.25 per cord, allowing $5 per acre for the cost of the land and $7.50 per acre for the cost of planting, compounding the cost of land and planting at 4 per cent annually for 50 years. This presupposes that all the 25,000 acres were bought at one time and planted during the first 25 years.

"Taxes and administration computed at 10 cents per acre per annum compounded at 4 per cent would amount to 31 cents per cord, based on a yield of 50 cords to the acre at 50 years.

"Taxes, of course, vary greatly in different regions, but the same ratio would hold true. For instance, with an annual tax of 20 cents per acre per year, under the same conditions, the cost of taxes would be 62 cents per cord.

"It is estimated that thinnings on this 50-year rotation would amount to eight or ten cords per acre without decreasing the final yield. These thinnings would to a considerable extent offset the cost of protection and taxes."

A. B. R.

Spruce in Minnesota. The Paper Mill, March 9, 1918, Vol. XLI, No. 10, pp. 16-18.

New Zealand Forests and Forestry

Upon the basis of the Oxford Survey of the British Empire and various commission reports, Sir William Schlich describes conditions and critically reviews proposed forest policies of this British colony.

The colony consists of two large islands, North and South Island, over 102,000 square miles, besides a number of smaller islands, the two main islands extending through a thousand miles north and south of the southern temperate or semi-tropical zone. A number of maps and text describes the physiographic and climatic features. The topography is diversified with mountain ranges, some of which reach into the region of eternal snow and with satisfactory rainfall conditions.

A short survey is given of populational and economic conditions. It appears that with over one million inhabitants, besides 50,000 native Maori, a considerable development of industries has taken place. Of these the forester is specially interested in the establishment of timber and paper mills and the kauri gum industry, the produce of former extensive forests of kauri (*Agathis* [*Dammara*] *australis*): the gum is dug out of the ground and its annual value is about half a million pounds sterling. On the whole, however, pastoral and agricultural pursuits overshadow all other industries, the number of sheep alone being about 24 million.

"The general character of the indigenous vegetation is distinctly semi-tropical, and the forest in particular is almost impenetrable in its native state, owing to the large number of lianas, which interlace and form an almost continuous mass of vegetation. Three-quarters of the indigenous plants are absolutely confined to New Zealand, and the difference between the plants of New Zealand and those of Australia is specially striking, considering the proximity of the two countries. There are over 100 species of timber trees, among which conifers are prominent. Only about a dozen species of trees are at present of real economic importance. Most of these are believed to be of very slow growth, an assertion which is rather surprising, considering the very thriving character of the climate. As a consequence, numerous exotic trees have been introduced."

The forest area, in the 25 years from 1886 to 1909 reduced by 20 per cent, comprises now, including scrub, 26,678 square miles, a forest per cent of 26. A little over 59 per cent of the area is crown forest, 3,300 square miles in permanent reservations, the balance privately owned. Only 9 of the 100 indigenous species can be called of commercial value. At the head stands the kauri pine (*Agathis australis*), one of the most valuable conifers of the world, but almost exterminated, the present stand being reduced to less than 1.5 per cent of the total stand of merchantable material, which is estimated at 33 billion "superficial" feet. The next best species, *Podocarpus totara*, is also almost reduced to the same low participation in the stand. Besides *Podocarpus spicatus* and *dacrydioides*, the latter called white pine, for butter boxes and packing boxes; *Dacrydium cupressinum*, called red pine, the most generally used and to be had in largest quantity; *Vitex* *lucens*, the strongest and most durable of the broadleaf trees for railway ties, there are three species of beech, commonly called birch, *Nothofagus fusca, salandri, menziesii*, which are found in the higher elevations, used principally for fencing and mine timbers.

The output of timber for 1913 is given as 358 million "superficial" feet (10 such feet being equal to 1 cubic foot) and imports in addition 33.5 million superficial feet, eucalypts from Australia and coniferous material from the United States, Canada, and even from the Baltic.

The realization that the native timber, with the present and naturally increasing demand, would probably be exhausted by 1945 has led to consideration of conservative forest policies and in 1896 to an ordinance inaugurating a system of State nurseries and plantations. By 1909, however, not more than 12,715 (by 1915, 68,500) acres had been planted, and the planting had been mostly of exotic species. A royal commission reported in that year on the situation, and in 1913 another commission was appointed, which reported at length. This report is in some respects a curiosity. The commissioners propose the establishment of *climatic* reserves and *scenic* reserves, but do not seem to have any confidence in *supply* reserves, excepting in the beech woods, "the only indigenous woods which regenerate themselves rapidly enough to warrant their permanent retention."

For the rest, reliance is placed on plantations and that mainly, if not entirely, with exotics, poplars, *Pinus insignis, radiata, laricio*, Douglas fir, and eucalypts. The main business to be provided for seems to be the butter industry, for which odorless packing cases are needed and for which the so-called white pine, occurring pure in swamps, furnishes best material, but in the plantations substitutes are to be secured. This policy of foreign importations is based on the—probably erroneous—idea that the native species are too slow growing. A large number of exotics have already been tested and found wanting.

The discussion of the financial aspects of such planting policy are also a curiosity and somewhat jumbled. It is expected that these plantations "when matured"—age not stated, but apparently 50 years—will average 50,000 superficial feet (100 cubic feet per acre per year), and for Monterey pine, fir for butter boxes, 150,000 superficial feet in 35 years!—over 400 cubic feet per acre per year! To meet the demand after the 35 years, 700,000 acres must be on hand, and spreading the planting over 50 years, 14,000 acres must be planted yearly. Such planting of Monterey pine on land worth $50 (!) is to cost $40 per acre; annual maintenance, $1.50; interest rate, 4.5 per cent; yield at 35 years, 150,000 superficial feet, worth $750, equal to 54 per cent on the outlay.

The organization proposed places the forestry branch not in the hands of a technical forester, but of an officer of "approved financial and administrative ability," with, however, an expert advisory board of at least four members. Not only are the native forests to be abandoned, but none but exotic species are recommended for planting, for which the employment of prison labor is suggested.

Schlich is showing up the incongruities of the scheme.

Forestry in the Dominion of New Zealand. Quarterly Journal of Forestry, January, 1918, pp. 1-28.

Length Growth of Trees

Although the learned dendrologist is not in doubt as regards the manner in which trees grow in height and is convinced that a nail driven into it does not change its position in relation to any other point vertically, the Indian Trigonometrical Survey, at the request of the Forest Department, has taken pains to verify the latter fact by establishing field bench-marks on trees and twice yearly for three years reading the levels on ten trees. The tabulated results show no change in the elevation of the marks except the very small fractional error which is chargeable to readings of this sort. In such cases, however, where the bench-marks are made by fixing the zinc plate horizontally to the bark or to sapwood after stripping the bark, the growth in girth had actually forced several of the plates from their nails, or they had at least been distorted.

Indian Forester, November and December, 1917, pp. 504-509.

Increment in India

In the absence of more tangible data as to the rate of growth in tropical forest, the somewhat insufficiently based tables of yield given by Marsden are of interest. There are six pages of them, referring to 22 species and nearly 500 items; the age is not always stated, but in most cases is for young stands below 60 years, in a few cases going over 100 years, and a very few over 200 years. The number of trees per acre and the annual increment per acre in cubic feet are stated. It is apparent that the number of trees are not for full stands, but the accidentally present of a given species; thus for the valuable *Shorea robusta* (Sal) the number runs from 80 to 1,707 and the increment from 43 to 187 cubic feet. The highest rate for native species, *Cedrus deodara*, 60 years old was 340 cubic feet per acre per year, while 30 to 40 year eucalypts planted made 474 to 527 cubic feet, and eucalypt coppice in 5 to 25 years grew at the rate of 729 to 860 cubic feet. Only in a few cases does the increment go over 200 feet.

For comparison a few European data of best performance are added, which show, if anything, about the same run as the Indian trees, or only a slightly smaller, up to 240 cubic feet for 110-year-old silver fir.

Comparative Yearly Volume Increments of Certain Indian Tree Crops. Indian Forester, January, 1918, pp. 10-16.

UTILIZATION, MARKET, AND TECHNOLOGY

Ailanthus for Paper

According to Fedele, as quoted in the *International Review*, the Ailanthus is recommended as an excellent paper-yielding plant, this opinion being based on experiments. It has the advantage of growing well everywhere, even in arid or purely rocky soils. It is a fast grower. By pollarding every three years and keeping the crown about 3 to 4 feet above the ground, the author obtained about 200 pounds of wood, which yielded 44 per cent of an easily bleached cellulose, suitable for paper pulp. One acre may contain from 240 to 280 trees, which under normal market conditions would give a profit of $40 per acre every three years.

International Review of Agriculture, February 8, 1918, p. 194.

Supply of Paper Material

In an article written especially for the annual number of the *Paper Trade Journal,* Martin L. Griffin points out that, in spite of the numerous experiments with many waste fibrous stalks and other material, it seems apparent that the manufacturers of news and book paper must, for years to come, depend on wood for their raw material. In spite of this, however, the pulp-wood supply is being allowed to approach the vanishing point with little apparent concern by the Government.

"Although it is generally recognized that our pulp-wood supply is approaching the vanishing point, there is a firm belief among many prominent men, not connected with the industry, that there are ample supplies of waste fibrous stalks which could be used as substitutes for wood, if only manufacturers would seriously turn their attention to them. Our public men in Washington have endeavored for many years to prove their contention by means of investigations conducted through the Bureau of Chemistry and the Forest Products Laboratory. The net results have been experimental only, showing that it is possible experimentally to make paper from any fibrous material, and also from many woods not now used for this purpose. I doubt if these results have furnished any information to manufacturers of paper or contributed materially to the solution of the problem. So far as I know, they have contributed nothing towards a substitute for wood for news and book papers.

"Unless wood is made available, the industry, as we know it today, must inevitably decline. It cannot live upon the uncertain by-products of other industries.

"Until municipalities and towns organize an efficient method of collecting and marketing waste paper, we cannot look for any great replacement value of paper stock by old paper, and there is little prospect of this. Even then it would be absurd to think that paper stock will not wear out and need replacement as much as anything else. Therefore, there must always be a dependable source of new raw material, and so long as it can be had, wood will be the chief dependence. And I repeat again what I said about the increased use of waste paper—the larger the use of by-product waste stalks of flax, corn, rice, and sugar-cane and such like, the higher will be the price of paper. As long as wood is available, at almost any price, it will be preferred for dominant reasons.

"It is regrettable that our large manufacturers have not taken more adequate means to insure their future supply of wood. If, instead of putting their money into profits and timberlands exclusively, they had put some part of it into reforesting lands they had cut over, their future supply would have been better protected.

"Although the necessity for protecting our forest growth has been generally recognized, the principal effort has been made in the direction of conserving what we have rather than in reforestation. It is still possible for private interests to take up the work of reforestation for their own protection, but the time is approaching when this will be no longer possible, and unless heroic efforts are made promptly the supply of wood will be exhausted before a new growth can be produced. Long ago the National and State governments should have realized this and taken steps to prevent it for the public welfare. Instead, however, they are proposing to defeat whatever initiative has been taken by fixing prices for newsprint paper. In a recent address before the bankers of Montreal, Elwood Wilson, chief forester of the Laurentide Company, said that unless a fair margin of profit was allowed, the first economies to be effected would be the abandonment of reforestation on cut-over lands and the stripping of the timber holdings by the companies to get their money out of the business, no matter what the consequences to the future.

"I do not complain of price-fixing *per se*, but of the failure of legislators to discern that unless they make provision for reforesting the denuded woodlands by including in the cost a definite proportion for reforestation, and compelling its use for this purpose, the paper industry will suffer on the cross of an impossible wood supply very soon.

"The principal function of the National and State governments in this matter deals principally with the maintenance of National and State parks, reservations, and public domains, and only incidentally fosters reforestation for commercial purposes.

"We are taking coal and oil from the earth which can never be replaced. We are stripping the surface of the forests, which, fortunately, it is possible to restore, and a nation-wide propaganda should be organized compelling the reforestation of a certain proportion of the waste lands in every State in the Union and the maintenance of a definite proportion of growing merchantable timber. What will we do about it?"

The reader is urged to consider Mr. Griffin's statements in conjunction with Dr. Fernow's article in the February number (especially pages 153-154) and the note on "Forestry and Paper Making," pages 258-260.

A. B. R.

Paper Trade Journal, New York, Vol. LXVI, No. 6, Feb. 7, 1918, pp. 93-97.

Swedish Forest Industries

Arosenius, in a short article, discusses the utilization features of forests in Sweden. He points out that the 90 million dollars or so of forest products exported in 1913 represents two-fifths of the total value of Swedish exports and makes Sweden the second largest exporter of wood materials in the world, the United States being first, with Russia and Austria following. During the years of the war this position, to be sure, has been improved, so that Sweden is now the first exporter in the world.

The high place occupied by Sweden in the international timber trade is primarily due to its many watercourses adapted to river driving. These have been systematically improved, and the river driving is carried on by booming associations under State control, charging a tax fixed by the provincial governments, some 16,000 miles of such watercourses being available. The sawmill and export business has been developed to its large extent since the middle of the century. At that time the abundant water powers available led to the location of mills where these could be developed, necessitating the transport of the mill product to shore; later steam sawmills were located on the coast, greatly cheapening the cost. There are now over 1,000 industrial mills, besides smaller home affairs. The detailed statistics of the mill industry are given. Pine (Scotch) and spruce are the only two woods exported, the pine being graded into five grades, but the spruce wood being shipped without classification. Two mills, one at Korsnaes and the other at Skutskaer, are believed to be the largest in Europe, working with 30 and 24 frames respectively, and shipping annually some 85 million feet b. m. The entire cut in 1913 was around 3 billion feet b. m. The export is increased slightly over this figure by unmanufactured material. The United Kingdom is by far the best customer, with over one-third of the total export. France comes next, then Denmark, and Germany; even Egypt, Africa, and Australia participate in the export. At present a larger than usual amount of mine props are being exported. In connection with the wood-pulp and cellulose industry the increased utilization of by-products is accentuated, and the possible increase in the production of alcohol by the wood-pulp factories is pointed out. Some 167 factories are in existence, half of them producing mechanical wood-pulp. Altogether somewhat over 1 million tons of paper-pulp were exported. It is interesting to note that charcoal production is still a significant item, and that it is largely manufactured from wood waste at the mills, either in meilers or in ovens. Of the 117 million bushels of charcoal used at the metallurgical works, over 30 million come from wood waste at the mills, but the bulk is still made in meilers in the forest. Various sawmills, also, have tar ovens, in which, besides the tar, other products of dry distillation are distilled from wood waste, and over $500,000 worth of such products is exported.

International Review of the Science and Practice of Agriculture, January, 1918, pp. 1-8.

MISCELLANEOUS

Roads Profitable

Even in far-away India the truth which the German foresters have long ago found out, that good roads pay, has been lately substantiated. The valuable Sal forest of Jariakhal was accessible only by means of a turbulent river, running by rapids through a forbidding gorge; it was practically inaccessible and no contractor could have afforded to pay more than 4 cents per cubic foot. A seven-mile road, partly through very difficult country, was built at a cost of around $13,000. The first felling, made this last winter, paid for the whole construction and a hundred per cent in addition on the investment! During the first 20 years it is expected to secure a revenue of $6,000 per annum net, after allowing for upkeep, etc.

Indian Forester, January, 1918, pp. 1-6.

What is a Cultigen?

L. H. Bailey coins a new term, "cultigen," in juxtaposition to "indigen," to designate plants in cultivation, the origin of many of them being unknown, as in the case of *Zea Mays*, canna, blackberries, roses, magnolias, and a host of others which may or may not be hybrids of known species. The interesting discussion is brought forward to point out the necessity for botanists not to treat these plants as outcasts, but to be recognized as facts in the nomenclature. The author does not advocate a particular proceeding, but merely asks the question, how these cases are to be handled.

The Indigen and Cultigen. Science, March 29, 1918, pp. 306-308.

EDITORIAL COMMENT

A Point of Professional Ethics

A recent publication on the seasoning of woods quite transcends the limits of endurance in the freedom of its unacknowledged borrowings from Forest Service published work. It will probably be necessary to deal with this case of plagiarism by communicating the facts to the scientific, technical, and trade journals. It is, however, far from being the first case in which writers have failed to give due credit to individuals in the Forest Service or to the Forest Service itself for material made use of. Foresters are naturally most interested in the question of professional ethics that is often involved.

In the scientific world generally writers of standing are scrupulously careful to make acknowledgments for all assistance received and to give full credit whenever material not strictly original is utilized. The jealous solicitude of investigators to protect themselves against possible loss of credit through publication of their results by others is occasionally carried to an extreme. In the profession of forestry there has been a great deal of liberality regarding the use of the results of study that would be of common benefit to the profession. There are a number of reasons for this.

One of the striking characteristics of the profession of forestry has been the relatively strong sense of solidarity which has permeated it. Its members have been knit together by a strong sense of a common public service and a sort of family feeling. This has been partly due to the predominant importance of public forestry, the newness and smallness of the profession, the extent of the personal acquaintance of its members with each other, and the resulting sense of fellowship. Men who are working together as closely as foresters in the United States have worked and are working naturally exchange and to some extent pool their ideas.

Again, the great bulk of the investigative work done in forestry in the United States has been done in the Forest Service. Published results, as a rule, represent a composite of work, in which are blended the thought of a number of individuals. Studies begun by one man may be taken up successively by several before they take final form, while the process of supervision, direction, and editorial revision may contribute largely to the outcome. In a certain sense, the Forest Service as an organization is the author of many of its official reports, quite as much as the man whose name appears on the title page. This in itself has led to liberality in the common professional use of the results of individual study.

As the main source of information on forestry matters, the Forest Service has sought to afford facilities to members of the profession who are not in the Service for keeping in touch with the progress of its research and administrative work. This has been regarded as necessary in the interests of the profession and in the long run of the Government work itself. It has been recognized that there were large accumulations of data which, under the general publication policy of the Service, would not become available in print for a long time, but which it was essential that the forest schools should have. Oftentimes information of this kind is embodied in manuscripts which require modification before they can be given official sanction as the conclusions of approved results of the Forest Service, but as the results of individuals are of large value to the specialist. By liberality in allowing members of the profession to make use of the information in its files or in the heads of its members, the Forest Service has been able to help the profession keep up to date.

Finally, when the Forest Service does publish its results they are not copyrighted. Any one who wishes to make use of information embodied in Government publications is legally free to do so. The only restraint on appropriation of material is that imposed by the conscience of the individual and the code of ethics which prevails among scientists and writers of standing with regard to plagiarism. To plagiarize is, according to one of the dictionary definitions, "to appropriate without due acknowledgment the ideas or expressions of another." The time has perhaps come for members of the profession of forestry to ponder with some care the limitations which professional courtesy and a scrupulous regard for the rights of others impose upon writers of books or of contributions to periodicals, when assistance is received or results are utilized in a way that might, without careful attention to the giving of credits, give rise to the suspicion of plagiarism.

HENRY S. GRAVES.

NOTES

Some Sidelights on a Great Canadian Industry

The Canadian Pulp and Paper Association has published a neat, small pamphlet entitled "Some Sidelights on a Great Canadian Industry." It contains speeches made by various contributors to the fifth annual meeting of the association, and may be considered campaign literature in the struggle between the newsprint manufacturers and the newspaper associations in trying to come to a reasonable price for the paper. As one speaker states: "The price of wheat, the necessity of life, has been fixed at more than 100 per cent over the pre-war figure. . . . Consequently, in fixing a price for news, we might reasonably expect to show an advance of 100 per cent. . . . All we asked was the very moderate prevailing advance of 50 per cent. . . . but were forced to sell our product at a wholly inadequate figure, at a figure less than its actual cost—the figure actually below the cost of production." As far as we could find out, no specific direct arguments are brought to justify increase in price. The interesting part of the publication is to be found in eight graphic illustrations showing the remarkable development of the pulp and paper industry in Canada. The first graph shows that, with a capital invested in pulp and paper, including manufactures, of 145.8 million dollars, this industry is the largest in the country, almost equalled only by log products, including pulpwood. The paper industry alone represents over 85 million dollars, and the woodpulp industry by itself over 47 million dollars. Another graph shows the remarkable development in exports of pulp in the last nine years from less than 4 million dollars to over 20 million dollars, and this increase is mainly in chemical pulp, from 1.5 to over 14 million dollars. In the same period of nine years the export of paper increased from 3 to 26 million dollars, mainly newsprint, which represents between 23 and 24 million dollars. Comparing the census figures for 1905 and 1915, the marvelous growth is still further accentuated as showing that the capital employed in the paper industry quadrupled in that time, although the number of mills increased only by 50 per cent, number of employees doubled, to near 16,000, while wages trebled, to 7.5 million dollars, and value of product trebled, from 9.5 to 29.4 million dollars.

The capital employed in pulp production also more than quadrupled (to 47.6 million dollars), but the value of the product only trebled (to 11 million dollars). The export of the pulpwood has remained during these last nine years nearly stationary, averaging about 950,000 cords per annum, while the pulp manufacture for home consumption increased, more or less fluctuating, from 483,000 to 1,765,000 cords. A most significant comparison is made regarding the relation of capital to product in various industries, which shows that the capital in paper manufacture produces a product value of only 33 per cent and the capital in pulpwood not quite 25 per cent of product value, while the iron and steel industry produces 66 per cent and flour and grist mills about 200 per cent on the invested capital. Finally, a graph is brought to show that if Canada kept all its pulpwood and allowed no export, it would "give sufficient raw material to double our present shipments of paper." A review of the historic development of the paper industry in Canada from 1803 on, when the first paper mill was established, adds interest to the publication.

Forest and Floods

Further news regarding the phenomenal floods in the Chihli province of China, the worst since 170 years, referred to on page 373 of this volume, comes through D. Y. Lin, M. F., in a small pamphlet used for forestry propaganda. Altogether nearly 18,000 villages, with 5.6 million homeless or starving population, are involved. Besides a very fair discussion of the forest influences on stream-flow in general, the opinions of a number of civil and hydraulic engineers are quoted, all of whom agree that, whatever may be done by expensive barrages and reservoirs to alleviate these floods in China, the only permanent relief can be found in a systematic plan of reforestation at the headwaters, which have been entirely deforested. The reasons for pinning faith in forest cover comes from the fact that the floods are caused mainly by the silting up of the water channels in the plain from the loess formation in the mountains. Such silting could hardly be efficiently taken care of by mechanical barriers and reservoirs, which would simply silt up themselves.

At the same time as the above there reaches us Water Supply Paper 426, of the U. S. Geological Survey, which describes the southern California floods of January, 1916—floods which occasioned around $10,000,000 damage to property and land and in which 28 persons perished. It gives on 80 pages of text and tabulations, accompanied by a map, a thorough account in detail of conditions and occurrences, but avoids any attempt at speculation as to causes and remedies.

While not directly stated, the inference is that the unusual concentrated rainfall alone accounts for the floods, which it undoubtedly does, and the inference also is hinted at that engineering works, especially reservoirs, will by themselves cure the soil. But the fact that several dams gave way; that thousands of acres were silted over, while forest conditions at the headquarters are described almost everywhere as poor, suggests that the Chinese engineers' broader outlook is justified, and that here, too, a better forest cover, which can be secured more cheaply than engineering works, might be useful. Unfortunately in California we have to deal, not as in China, with a timber-forest country, but a semi-arid locality, and the forest planting will perhaps have largely to be done with shrubs, or at least without regard to economic value of the timber.

Municipal Wood Yards

The acute fuel shortage of last winter has borne fruit in several ways in an increased production and use of wood fuel. One of the most significant results is the passage of an act by the legislature of Mississippi authorizing municipalities to establish and operate municipal wood and coal yards. The essential features of the law will be of special interest in view of the country-wide effort being made at this season to provide against a shortage next winter, which is practically inevitable, according to the Federal Fuel Administration. By this law:

(*a*) The authorities of every municipality are authorized to establish and operate wood and coal yards during the period until one year after the close of the present war, for the purpose of supplying the inhabitants with fuel.

(*b*) A municipality which establishes and operates a wood yard, coal yard, or either, shall have full power to create, fill, discontinue, or abolish all such offices or employments in connection therewith as may be deemed necessary or proper; to fix and pay salaries; to cut, purchase, transport, sell, and deliver wood or coal necessary for providing the inhabitants with fuel; from time to time fix the selling prices and the terms of sale, and to make and enforce such rules and regulations as may be necessary for the carrying out of the act.

(*c*) The necessary funds are to be set aside out of the general municipal fund or borrowed at interest on the credit of the municipality.

(*d*) In order to borrow money for this purpose, the municipality is required to publish in local papers for a period of ten days a full statement of its intentions, stating the sum and rate of interest to be paid. In case a protest is filed before the expiration of the period of advertisement, signed by at least 25 per cent of the qualified electors of the municipality, the question must then be submitted in an election, requiring for passage the approval of a majority of the qualified electors.

This law is to be commended as eminently wise and timely and should be widely considered. Similar action by other States would remove a serious difficulty that came up in hundreds of cases in the eastern United States last winter, preventing cities and towns from taking active relief measures in keeping the people warm and supplying power to essential commercial enterprises.

W. R. M.

Col. Henry S. Graves, Forester of the United States Forest Service, has been elected honorary member of the Royal Scottish Arboricultural Society of Edinburgh, Scotland, in recognition of his eminent services to forestry. This distinction is shared by Colonel Graves with only one other citizen of this country, Dr. C. S. Sargent, who was elected in 1889.

The National Forest Reservation Commission's report for the year ending June 30, 1917, has been printed as H. R. Doc. No. 564, Sixty-fifth Congress, second session—a pamphlet of only ten pages. From this the following facts are disclosed:

During the fiscal year only 175,463 acres have been added to the Eastern reserves, mostly to consolidate previous purchases, the prices ranging from $3.19 to $6.90, averaging $4.86 per acre, the total expenditure being $852,524. Previously purchased or approved for purchase were 1,501,357 acres, averaging $5.22 per acre, although so far only 947,197 acres have been actually acquired. Of the 1.5 million acres, around 35 per cent in virgin timber, 10 per cent young growth, a similar amount burned, barren and with unmerchantable timber, 23,251 acres abandoned farms, the balance culled and cut over. The total of the White Mountain purchases comprise around 450,000 acres. The detail of purchases is given in a table. Of the original $11,000,000 appropriated in 1911 and reappropriated, altogether $8,348,616 have been used, leaving over 2.5 million dollars available.

As regards development of these lands, there are now 421 miles of telephone lines and 850 miles of trail constructed and a number of lookout stations, and by use and sale of resources an income of $22,154 was secured. The Pisgah National Forest and Game Preserve were established by proclamation.

At the same time as the above purchases were made 10,500 acres of public timber lands in Alabama have by Presidential proclamation been set aside as National Forest, and it is expected that by further purchases a unit of about 150,000 acres will be here established. Much of this land consists of poor abandoned homesteads at the headwaters of Sipsey River, a tributary to Warrior River, where the Government is building extensive locks and dams.

The Commission wisely refuses "to make further purchases in Georgia until after the repeal of hostile legislation passed by the State last summer. About 27,800 acres on the Savannah and Georgia purchase areas, which were recommended to the Commission, will be held up by this resolution. The Commission also refused to approve the purchase of a tract on the Unaka Area in Tennessee, for which a higher price than that agreed to by the owner was awarded by the jury in condemnation proceedings brought with the owner's consent to clear the title."

We may add that the total acreage of National Forests was on June 30, 1917, 155,166,619 acres. The receipts from the National Forests in the fiscal year 1916 amounted to $2,823,541 and in 1917 to $3,457,028, while the appropriations during the past year amounted to $5,549,735. Of this amount only about four million dollars are chargeable to the National Forests, the balance being used in investigative and educational work; so that the income was only about a half million dollars less than the expenses of protection and administration.

A set of important bills, denoting remarkable progress in forest taxation, were passed this winter by the New York legislature; they have reference more particularly to "lands and growing trees dedicated to continuous forest service."

Bills 1181:1660 and 190:965:1590 provide for taxation of forest lands of 50 acres and upward, and also recognize the propriety of assessing soil and growing stock separately, the fairness of the assessment to be under the judgment and advice of the Conservation Commission. But this is not to apply to natural forests from which the growing trees are "not cut within 35 years after the date of their classification as forest lands dedicated to continuous forest service." The classification and certification of such forest lands is to be done by the

Conservation Commission. The tax on the timber is to be paid by the State; but when the timber is being cut to be refunded by the owner, with 4 per cent simple interest added.

There are provisions for revocation of classification by the Conservation Commission and by the owner. In that event the accrued taxes must be paid with interest thereon at 4 per cent.

These bills were vetoed by Governor Whitman on May 15.

A further move to bring the State of New York to a somewhat saner forest policy has been made by the adoption in the legislature of a concurrent resolution to amend article VII of the Constitution, to the effect that the construction of municipal and State water reservoirs on State forest lands may be permitted, by legislative act, under defined conditions, and that dead and fallen timber on these lands, for fuel or other domestic purposes and for construction of roads and trails, may be authorized by the legislature. To make this effective the legislature of 1919 must pass it again, and if then accepted by the electorate it may come into practice by January 1, 1920.

Meanwhile the lands are to be "forever kept as wild forest lands," which does not prevent their being planted up.

In connection with this movement an article by G. N. Ostrander, President of the Empire State Forest Products Association, in *State Service*, II, 3, pp. 29-32, is of interest. It is accompanied by financial yield tables of white pine and Norway spruce, intended to show that forestry does not pay; that it is a communal concern. This, to be sure, is based upon an untenable 6-per-cent compound calculation and without adequate allowance for rise of prices. We are, however, agreed on the general proposition on account of the long-time element, and for this reason that forest management is not attractive to private enterprise. There seems to have been no result from the legislation in 1912, which allows exemption from taxation for lands classified as permanent timber lands. The writer advocates entire exemption from taxes during the life of the stand, with a yield tax at the end, such as the States of Connecticut, Massachusetts, Pennsylvania, and Vermont have now on their statutes. The writer also advocates assistance in reforestation by the States.

The importance of providing fodder in times of scarcity has led the Forestry Department of New South Wales to reopen their offer of two years ago, through the Secretary of the New South Wales Forestry Commission, Sydney, to supply seedlings of suitable species to all graziers willing to comply with conditions which will insure that the trees will have reasonable treatment—for the present, casuarinas, kurrajong, carob-bean, tree lucerne, and native salt-bush.

The commissioners offer—

1. To supply without charge sufficient fodder seedlings to plant, 20 feet apart, an area or areas of from one acre to ten acres. The plants will be selected from the forest nurseries in different parts of the State and forwarded by train to the railway station most convenient to the applicant.

2. To direct, supervise, and give advice regarding the planting and subsequent care of the plantations.

3. To set aside a sum of not less than £150 to be expended every three years in prizes for the best fodder plantations established under this scheme in the central and western districts of New South Wales.

In return they require that the participant fulfill the following conditions:

1. To pay the cost of carrying by rail of the plants.

2. To plow the site for planting to as great a depth as possible, ready for the reception of the plants.

3. To inclose the plantation securely with stock and vermin-proof fencing.

4. To. provide the cultivation and regular attention essential to the proper growth of the trees.

5. To take adequate precautions to protect the plantation against damage by fire.

In 1912 a number of sample plots were established on cutting areas in various types throughout the National Forests of California. These plots were remeasured in 1917 and the data have now been compiled. They show that the rate of growth in the Jeffrey pine type on the entire eastern slope of the Sierra Nevadas is so low that profitable forest management from a purely monetary standpoint appears to be entirely out of the question, while on the west slope a rate of interest expressed as volume growth percentage as high as 5 or 6 per cent per annum now appears obtainable on the yellow-pine and sugar-pine sites. The early marking in this district contemplated a second cut in from thirty to fifty years. As a result of the remeasurement of these plots, District 5 officers are now of the opinion that on the eastern side of the Sierras clear cutting should have been practiced, without thought of a second harvest, until the young growth had matured. On the west slope it is evident that the second-cut idea can be carried out, and that the system of marking practiced five or six years ago cannot be improved upon to any great extent. The remeasurements also indicate that the growth of the tree is not appreciably checked by severe logging damage to the base, while if a portion of the crown is injured growth slows up very appreciably. Trees with wide, long, and pointed crowns make much more rapid growth than those with any other character of top.

In a well-illustrated article of the New York *Paper Trade Journal* Julian Rothery points out that forests, vast as they are, are not unbounded, and that the amount of pulp-wood available in this country and Canada which will permit of manufacture of reasonably cheap paper is not bottomless. He gives some interesting facts about what one paper firm has done in the way of reforestation and how its nurseries are conducted. To quote Mr. Rothery:

"The Pejepscot Paper Company is one of the old established manufacturers, with mills on the lower Androscoggin River in Maine and extensive timber lands both in Maine and Canada. It was also among the foremost to embark on a far-sighted policy of conservation, and its New Brunswick holdings constitute the finest spruce forest the writer has ever seen and probably the finest in eastern America. Due to careful methods of cutting, there is more timber upon the lands today than when operations were commenced many years ago. But it is the reforesting of the barren or open lands where conservation is the most direct and aggressive. The Pejepscot Paper Company established nurseries at several places in its woodland properties.

"Thousands of these young trees have been set out in the old pastures and clearings and are slowly filling up gaps in the woodland cover. The cost is not heavy; the returns, both direct and indirect, are sufficient to make it an object to continue the work each year until now, when the open areas of their large Canadian properties are nearly all restocked with valuable growing trees. They find planting is educational as well as practical, tending to promote care of the forest and impress upon observers the value of trees and forest cover."

Although it is not likely that the forest, which is now expected to eke out the coming coal shortage, will also contribute much toward staving off the food shortage, a short note on forest trees with edible fruits in *Forest Leaves* is of interest and at least suggestive.

Of first importance are, of course, the various nuts—walnut, butternut, chestnut and chinquapin, hazelnut and hickory (pecan), as well as beechnut, the latter to furnish a substitute for olive oil. Of acorns, the white oaks are sweet enough to eat, but the black-oak acorns can be made fit by pulping and leaching them with hot water. The same treatment will make the horse-chestnuts useful for flour. Persimmon, pawpaw, and wild plums and cherries must be well ripened before losing their puckeriness. Wild crab-apple makes delicious jelly. Shadbush or June berry, hackberry, elderberry, and mulberry can be used for the same purposes for pies or sauce. Less known is the use of the acid redbud flowers in salads and pickle, of the mesquite fruit, and buds of sassafras; but every boy knows the honey-shucks of the honey locust. Finally, may be mentioned the several nut pines of the West and the longleaf-pine nut of the South for tid-bits.

Although the Indian Forest Department has been in existence over fifty years, there is still need to awaken public interest in its work, according to a writer in the *Indian Forester* (October, 1917). This is partly due to the fact that the Inspector General is nothing but a technical adviser, while the responsible official, who holds the portfolio in the government council, is the member in charge of the Department of Revenue and Agriculture; "the driving force is never likely to come from that quarter"; a strong public opinion alone can set it in motion.

Since Lord Dalhousie, in 1855, framed a definite forest policy, out of a total of around 250,000 square miles of forest area, 97,580 square miles have been reserved, 10,405 square miles have been classed as protected forest, the large balance remaining unclassified.

So far, so good; but now more detail development is necessary for commercial purposes. "Money is wanted for communications, for up-to-date methods of transportation, for giving the lead to forest industries." Reference is particularly made to the possibilities of developing the paper industry; India to become an exporter of paper to all countries, the supply of bamboo and grasses for this use being unlimited.

That the Indian Forest Department is not ideally organized, manned, paid, pensioned, and run appears from various communications in recent numbers of the *Indian Forester*. In controversial correspondence with the former Inspector General himself, one deputy conservator complains of the low salaries and inadequate pensions for higher-grade officers as compared with what men in private employ secure. The findings of the Public Service Commission—(1) that within a measurable period the department can be entirely manned by officers educated in India; (2) that remuneration on a scale approximately half that offered to officers of the Indian Civil Service is sufficient to attract the necessary brain-power to the department—are being doubted, for "even if the enlarged Forest College at Dehra Dun will be in a position to inculcate the scientific basis for forest work, it is hard to see what fount of education in India will be able, within a similar period, to infuse the foresight, breadth of view, and business acumen necessary for the proper management of the commercial end of the department."

Mr. Hu Maxwell, in *American Forestry* for April, brings together interesting information regarding medicinal properties of trees and a few other plants as used by the Indians. The following species by some part or other—buds, leaves, twigs, bark, roots, fruit—furnished the materia medica: Cherry, dogwood (*Cornus florida*), beech (*Fagus atropunicea*), Virginia snake root (*Aristolochia serpentaria*), Seneca snake root (*Polygalia senega*), yellow poplar (*Liriodendron tulipifera*), Angelica tree, or prickly ash (*Aralia spinosa*), Hercules club (*Xanthoxylum clavahercules*), butternut (*Juglans cinerea*), elder (*Sambucus canadensis*) (applied externally only), umbrella tree (*Magnolia tripetala*), hickory, black walnut, white ash, arborvitæ (*Thuja occidentalis*), slippery elm (*Ulmus pubescens*), white pine (*Pinus strobus*), sassafras, mesquite (*Prosopis juliflora*), yaupon holly (*Ilex vomitoria*), greasewood (*Covillea tridentata*).

A note in *Forest Leaves* (December, 1917) points out that the substitution of fuelwood for coal should be made where team haul instead of railroad haul is practicable, and especially where heat is required only occasionally, as in churches, halls, summer cottages, etc. Fuel values for various woods are given, seasoned wood being understood, varying between one and two cords equivalent to a ton of anthracite. A table shows a comparison of money values per cord of wood and ton of coal at which equal fuel values are secured.

"If the consumer can buy coal at $8 a ton, it would hardly be worth his while to burn first-class wood at $8 a cord, except in an open fireplace, because coal is a more convenient fuel. If, however, coal becomes so scarce that it cannot be secured in sufficient quantities, the consumer will, in some cases, have to burn wood at $10 or even $15 a cord.

The lower grades of California pine are used very extensively in the manufacture of boxes. Because of the large fruit crop in 1917, as well as the prospects for an excellent crop this year, an unusually heavy demand for box lumber has led to an increase in price of from about $13 per thousand to about $25 per thousand. The demand for box shook has been so heavy that a number of fruit-packing concerns have found it impossible to contract for a supply to serve their needs. This has induced some of them to go into the manufacture of box lumber, and several sales of National Forest stumpage have been made direct to these consumers of lumber. It will be interesting to watch the history of these concerns, particularly if conditions such as those in the lumber industry several years ago again develop.

As a silvicultural operation it may become necessary to kill trees that cannot be profitably exploited, to give light to others. An Indian forester has made the discovery that this is most easily, cheaply, and efficiently done by employing Atlas Preservative (composition not stated). It kills the tree in a fortnight, being applied with a brush after light girdling—that is, cutting through the outer bark. One gallon will kill many trees, at the same time preserving the wood, even against white ants, as the preservative penetrates the whole tree.—*Indian Forester*, 1918, p. 23.

The district forester at San Francisco has recently received an application from a firm located near the Angeles Forest for 100 tons of leaves of the yucca plant, locally known as Spanish dagger. Up to this time this plant has been considered as absolutely worthless and has been regarded as a considerable fire menace. The fiber obtained from the dried leaves will be used in the manufacture of brooms, which will be sold for about $6 per dozen in comparison to about $8 per dozen for corn brooms. One ton of yucca fiber will produce about 800 brooms.

One of the many devices used by the Canadian Forestry Association to reach the school children of Canada is through a series of attractively printed "forest talks." Each address is accompanied by several large cards containing illustrations, the latter being passed about the class-rooms at the close of the reading. School teachers in all parts of Canada are making use of these periodical addresses on forestry.

Arguing that the coal supply will be short for the next two years, and that hardwoods are needed in the distillation works to produce acetate used in the manufacture of munitions, and moreover needs to be seasoned for fuel, the Minnesota Commission of Public Safety calls attention to the dead tamarack as a satisfactory fuel upon the basis of ten years' experience.

The U. S. Forest Service has established a eucalyptus arboretum on the Angeles Forest, near San Bernardino, and at present thirty species of eucalyptus are being grown there, each in a separate plot. Seed of the rarer species was obtained direct from Australia. It is proposed to continue this work until all eucalypts of any importance are included in the arboretum.

A ludicrous perversion of news occurred when Mr. Graves and his council arrived in Paris last June and *Le Temps* announced that these American foresters had been imported to begin at once the reforestation of the devastated French forests. This led to an interpellation in the Chamber of Deputies, when the true mission in the opposite direction was revealed.

In spite of its timber wealth, India is importing considerable and increasing amounts of lumber from Japan and the United States and from other countries. In 1916-1917 the deal and pine import alone amounted to around $1,200,000 and $1,400,000 of other materials, while the total wood import from all countries amounted to around $3,-300,000.

A meeting of Minnesota district forest rangers and railroad officials was held at McKay Hotel, Duluth, Minn., on April 8, to discuss fire-protection work by railroads. A frank discussion ensued, which apparently made the meeting a profitable one, the special point at issue being the relation between settling damage claims and fire-prevention work.

In the Canadian *Pulp and Paper Magazine* of May 9, H. N. Lee and R. W. Hovey, of the Canadian Forest Products Laboratory, begin a very useful discussion on the principal properties, structure, and identification of Canadian pulpwoods. In the first section the structural characteristics for identification are given by illustration and description.

"Geoteresy" is a new convenient term invented by Coldstream, of the Indian Service, to denote the operations for the protection of soil surface against erosion by torrents, river, sea, or submersion by these agencies; also by sand-drift and silting; the word comes from the Greek for earth and protect.

There are now around 70,000 square miles of timberland in the Province of Quebec under efficient fire patrol by four forest protective associations, 56,000 of which are under license and about 2,500 square miles in private ownership, the balance being unlicensed crown lands.

The prices of imported lumber in London, according to a bulletin by the English Forestry Association, have increased since 1913 from three to five fold. Flooring, for instance, which in 1913 brought around $30 per thousand, in 1917 sold for near $120.

To avoid damage by spring frost to the leader of newly planted exotics, a Scotch forester relates his experiences with moving such plants in the nursery one year before transplanting, which checks the development of long leaders.

An active demand for willow is reported from Toronto for the manufacture of wooden legs and arms by an artificial limb company, which turns over practically its entire output to the government for the use of disabled soldiers.

Mr. R. Zon and Dr. J. W. Bailey have been appointed members of the Executive Committee of the Division of Agriculture and Forestry in the National Research Council.

Five large camps have been established in the Pennsylvania State forests, from which it is proposed to plant 5,000,000 trees during April and May, 1918.

The summer meeting of the Pennsylvania Forestry Association will be held at Pocono Manor, Pa., June 26-28, 1918.

Cellulose from seaweed and a paper milk bottle are the latest additions to the paper industry extension.

Notes from District 1

Plans are being made by Dr. J. R. Weir, in District 1, to continue the eradication work on the white-pine blister rust this season. The Missoula laboratory will have charge of the work in the States of Montana, Idaho, Wyoming, South Dakota, and parts of Washington. Dr. Alfred H. W. Povah, Assistant Professor of Forest Botany at Syracuse University, will handle the details of the survey, with headquarters at Missoula. The region will be divided between six or seven men, who will be continually in the field. The work will begin May 1 and end about October 1.

The regular work in forest pathology for the season will be chiefly centered on rots of cedar in relation to the pole industry, relation of fire to decay, etc., and other problems bearing on the management of white pine and larch. Mr. E. E. Hubert will handle a field party on this work in the western end of the district. Investigations on the life histories of various rust fungi of conifers which are known to be injurious to seedlings and transplants are being continued this year.

The Office of Silviculture, in District 1, plans on making a study of the brush-disposal problems on several of the forests in the Inland Empire region, under the direction of H. L. Baker. The aim will be to determine the silvicultural results that are obtained when the brush is piled and burned later and when it is thrown directly on to fires. Data will be collected for different sites and types under varying weather conditions for both systems of brush disposal. A comparison will be made of the percentage of trees killed or injured, the amount of ground burned over per acre, costs, and conditions under which both systems of brush disposal are applicable. The chief objection to the system of brush disposal where fires are started and the brush thrown on to them seems to be the initial cost and the difficulty experienced in starting the fires. Experiments conducted on the Selway Forest, where it is difficult to burn piled brush because of the frequent rains, indicate that far better silvicultural results are obtained where the brush is thrown directly on to the fires. It is hoped to overcome the chief objection to this system of brush disposal by using a Hauck blow-torch for starting the fires. This outfit is commonly used to thaw out frozen pipes and railroad switches. It is being used by the Potlatch Lumber Company to burn out stumps. Extensive experiments will be made with this new brush burner.

Three men will be sent out this summer by the Office of Grazing to make an inspection of the range and take an inventory of forage resources of ten of the western forests of District 1. They will collect information on the improvements and development work needed to make possible the development of grazing to the highest extent economic conditions will allow. The effect of grazing on white pine will be studied with especial care in order that a grazing policy may be established that will fit the conditions.

Some time ago Supervisor M. H. Wolff, of the Cœur d'Alene Forest, carried out some experiments in girdling hemlock by means of acetylene blow-torches. The result was not encouraging, either from the standpoint of cost or effectiveness. Unfortunately the trees experimented upon were burned last summer in a forest fire, so that the actual effect in killing the trees cannot be determined.

Supervisor Elers Koch, of the Lolo National Forest, has been detailed to the Branch of Research of the Washington office, with headquarters in Washington. It is expected that the detail will be for the period of the war. Supervisor White, of the Bitterroot National Forest, will take over the supervision of the Lolo in addition to his duties on the Bitterroot.

W. B. Willey, formerly supervisor of the Clearwater National Forest, has been transferred to the Jefferson National Forest, vice Scott Leavitt, resigned. R. A. Hamilton, formerly deputy supervisor of the Deerlodge, has taken Mr. Willey's place as supervisor of the Clearwater.

Stephen St. J. Malven has resigned as deputy supervisor of the Flathead National Forest to take up work for the Western Pine Association, with headquarters at Portland, Oregon. His position has been filled by L. G. Hornby.

E. C. Rogers has been reinstated in the Forest Service and will continue his work in planting investigations in District 1. He resigned last fall to take postgraduate work at Johns Hopkins University.

W. F. Tribe, scaler in the Forest Service, District 3, has resigned to engage in private business in Salt Lake City.

C. K. McHarg, former supervisor of the Nezperce, has been transferred to the Helena in the same capacity. S. V. Fullaway, Jr., has taken Mr. McHarg's place as supervisor of the Nezperce.

Paul C. Kitchin has been transferred from the Priest River Experiment Station to the Savenac Nursery, where he will assist E. C. Rogers in planting investigative work.

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SOME FUNDAMENTAL PROBLEMS IN FORESTRY EDUCATION *

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The establishment of nearly all the forest schools came as a direct result of the establishment of a National Forest policy. The courses were originally outlined with direct reference to Government work, and for a number of years practically all of the graduates entered Government service. The subject-matter of the courses was based very largely upon European systems, and although the curricula were outlined with reference to a thoroughly broad education, the entire scheme contemplated the training of specialists in silvicultural practice and forest management. There was no profession of forestry in this country at that time; the student did not know just what he had before him. It was up to him to develop the profession. From the standpoint of the nation, there were two large problems: (1) Investigation, (2) propaganda. It was up to the nation to find out what it had and what to do with it. In other words, it was necessary to first discover the problems and to develop public sentiment in favor of the right solution of these problems. For these reasons the system that was adopted, namely, that of requiring a broad, general education, followed by a study of the theory and practice of well-established European methods of forestry (with such modifications as our own conditions early suggested), was without doubt the right way to begin forest education in this country. A knowledge of all technical details of forestry was less important in the development of a national forest policy than a thoroughly broad conception of the meaning of forestry and its relation to national problems. It is true that the exact status of affairs was not fully realized at the time, so that some premature attempts at carrying out technical details were made. Fortunately these did not lead to very disastrous

* A contribution to the discussion of the paper on "The Technical Forester in National Forest Administration," Vol XVI, No. 2, JOURNAL OF FORESTRY.

results, and they served as valuable stepping-stones in a fuller realization of the problems.

As time went on the National Forest area grew rapidly. Administration problems developed. The need for technical men grew. Forest schools began to multiply. A need for specialists began to show itself in various directions. In short, conditions changed rapidly. We found that protection in all of its phases was the first great administrative problem; that the practice of silvicultural methods needed to be preceded by extensive scientific studies, and that intensive forest organization and working plans were a thing of the future. While the training in the forest schools was designed to make all of the graduates specialists in silviculture and management, conditions actually developing in the field made it necessary to use a very large proportion of them, both in the Service and out of it, in work where silviculture and management were only of very secondary importance. We must admit that a broad knowledge of silviculture and management has been important at all times, and always will be, for the professional forester. Yet we must also admit, and it has been admitted by technical men time after time, that the training they received in the early days of forest schools for the problems that confronted them immediately upon graduation was very meager indeed. This was, of course, even more serious for those who went directly into the work in forest products, and in various capacities into the employ of commercial organizations, than for those who took up National Forest work.

In following up the development of the problems of forestry in this country, it is easy to call to mind men who have gone into special fields of work who were very far from properly trained for those fields. Their knowledge of silviculture and management was useful, but its value was secondary rather than primary. These men were the pioneers in fire protection, grazing, logging engineering, wood preservation, and a great deal of the work in forest products.[1] That they made good was due to their broad general training, and hence their ability to adapt themselves to new conditions, and we might say, just as emphatically, to their utter lack of competition. Had there been any high-class technical competition it is doubtful whether these men would have been able to remain in the race. It is not the object of the author to offer this as a criticism against the forest schools as they existed during the days when forestry was infantile. The question, however, arises at the

[1] The author realizes that protection, grazing, etc., are problems of organization, but uses the terms here in reference to technical details of administration.

present time as to whether the forest schools have kept up with developments as fully as they should.

Let us glance back over the past once more. With the rapid growth of the forestry movement there came also a rapid increase in the number of forest schools. During the past few years the bugaboo of the overcrowding of the forestry profession caused considerable anxiety both among the school men and those in the Service.[2] The school men were continually confronted by "What are you going to do with all the young foresters?" until they began to wonder about it themselves. Here, again, there have been changing conditions that have solved the problem completely. The graduates have made places for themselves by entering fields hitherto not properly served by technical men. This has resulted in two rather severe criticisms of the forest schools: (1) That they were shunting their graduates off into fields of work only remotely associated with forestry, and (2) if they modified their curricula to meet the new conditions, that they were drifting away from forestry and trespassing in the fields of other established departments of the university organization.[3] Both of these criticisms hinge on the question, "What is the legitimate field of the forest school?" and closely associated with this, "What is a forester?"

If informal discussion by small groups of interested men may be taken as any indication, these questions will perhaps stir up a goodly amount of controversy. The author will not attempt a complete answer to the question, "What is a forester?" but he does feel that the term "forester" has been too closely hedged in by its relation to silviculture and management. It is time for the profession to recognize that forestry is not like a dead language, but that it is a living. growing system of knowledge. In this connection it should not be necessary to have to refer to the history of the term. The field of the forester has changed in the past; it is now undergoing some marked changes, and we may expect it to change still more in the future. And why should we not reach out and develop our field of useful endeavor through every legitimate channel? The mere reason that a man is a specialist in some phase of forestry not directly associated with silvicultural practice or forest management has been sufficient in the past to brand him as not worthy a place in the profession. Quite recently one of the membership committee of the Society voted against a forest-school graduate of some accomplishment and considerable promise in wood preservation

[2] Toumey: The Interdependence of Forest Conservation and Forestry Education. Science, N. S., Vol. XLIV, No. 1132, p. 327.

[3] Olmstead: What is a Forester? J. F., Vol. XI, p. 230.

because, as he put it, "his accomplishments are all in an allied field, with nothing to show in forestry."

The term "forester," in its literal sense, is indeed a term of limited meaning. The terms used to designate other worthy professions are not quite so limited, nor, would it seem, are these professions so jealous. "Civil engineering," for example, is so broad a term that the profession can claim almost any really good technical man, and it welcomes him with open arms. Of course, we emphatically do not want to dignify all of the tree doctors, forest guards, and others who have little or no professional training with the title of forester; but there is growing up within our profession a group of specialists who are only to a lesser degree concerned with silvicultural practice and forest management, and whose special lines of endeavor are the direct outgrowth of the activities of the Forest Service and the forest schools. Such, for example, are the specialists in various of the "products" lines. These men are being claimed by the engineers, who have no right to them. They are a real product of forestry.[4]

A comparison of the forest-school curricula with the various activities of the Forest Service and the forest industries will show that the schools have not digressed very far from their proper functions. If they are deserving of any criticism it should rather be for not following up more closely the needs of their graduates as a determining factor in the development of the curricula. The forest schools simply did not realize fully their opportunities. There is now a growing tendency among the educators to correct this situation, but the majority of the schools fall far short in their attempt because of the lack of physical equipment and the type of instructor required to make the work at all efficient. Although the majority of the schools are doing very good work in some lines, many of them are very poorly equipped for carrying out efficiently *all of the specialized work they are advertising.*

If I may so far presume, I should like also to offer an observation and a criticism along this line concerning the Forest Service. I think that the Forest Service has shown a *partial* recognition of this state of affairs which is illustrated, for example, in the personnel of its staff at the Madison Laboratory. At any rate the staff at Madison shows—since it is composed of a goodly number of engineers—that foresters did not have the training needed for a large part of the work promulgated there. On the other hand, a little analysis and reflection will

[4] It is true that numerous exceptions concerning admissions have been made by the Society, yet the fact remains that there is among many of the members a strong prejudice against persons not associated with some phase of the work in silviculture and management.

readily convince any one that a person with a purely engineering training is absolutely lacking in any basic knowledge of wood. A broad understanding of these problems requires a properly correlated knowledge of both forestry and engineering, and unless thoroughly correlated cannot be wholly efficient. Of course, in the distant past the Service has not been to blame for such a condition, but it is not wholly free from criticism for allowing such a condition to persist. A very few of the schools have recognized the difficulty, and have tried to remedy it by enabling the student to take a combined course of training in forestry and engineering, calculated to give the Service men with a foundation such that they might reasonably be expected to develop into the exact type needed. But instead of recognizing the effort these schools are making, the Service persistently states in its announcements of civil-service examinations in the majority of lines in forest products that *applicants must be graduates in civil, mechanical, or chemical engineering*, as the case may be, thus at the outset denying the forest-school graduate even an opportunity of showing what he can do.

The writer knows of specific cases where engineers were trying to deal with problems involving a thorough knowledge of the structure of wood who didn't know the difference between a tracheid and medullary ray. This state of affairs has occasionally led to utterly ridiculous statements. Fortunately such statements are usually caught before they appear in print. Yet, since practically all questions in forest products involve a thorough knowledge of the structure and the physical qualities of wood, it certainly seems that we have been overlooking something in the preparation and the selection of men for these lines of work, and that the forest schools that are making an effort to give their students the proper combined training in forestry and engineering, forestry and chemistry, or whatever the particular case may call for, are not being given the proper consideration. Experience at the University of Washington shows that it is quite possible in a five-year course to give students an amply sufficient training in such a combination of subjects and to correlate them in a way to make the students efficient and successful workers.

Coming back, now, to the legitimate field of the forest school, I should say that it includes the work in lumbering, logging engineering, wood preservation, timber inspection; in fact, all phases of the work in forest production, forest management, forest engineering, and forest utilization, even to the point of certain specialized work in marketing. It is true that we have been giving at least a smattering of all this work. However, the fields of work our graduates have entered show beyond all question of a doubt that the forest schools should offer the students opportunity for as thorough specialization in all of these subjects as in silviculture and management. Even a superficial survey of the work forest-school graduates are now engaged in shows that in a great many instances silviculture is only of secondary importance. I would not, however, wish the reader to infer that a general knowledge of silviculture, or any of the other fundamental forestry subjects, is unnecessary in any one of the fields enumerated above. Let me illustrate this point by just one of many examples that might be given. The work in timber testing at first thought seems quite remote from silviculture. Yet the Forest Service has been considering a project in which it is being shown that strength values in wood are related to the silvicultural conditions under which the timber was grown. It is a simple matter to teach a person to run a testing machine, but it is an entirely different matter to have him understand all the possible influencing conditions that may affect his final results. Scientific work often has little value, and certainly cannot extend its influence as far as it should, unless all influencing conditions are taken into consideration.

There are those who believe that much of the work outlined above as belonging to the field of the forest school should rightly be developed by other than the forestry departments of the university. With all due respect to the persons not educated in forest schools successfully engaged in these fields, either in the Service or out of it, we must admit that the botany and chemistry departments and engineering schools that tried to enter them have largely, and sometimes grossly, failed in their efforts. A number of books now on the market on subjects relating to forestry by engineers and others show quite distinctly their lack of ability to handle these subjects. In his most excellent article, "The Place of Forestry among the Natural Sciences," [5] Forester Graves has pointed out that in the field in which forestry and botany overlap the botanist has not yet reached a point where *foresters* can leave wholly to botanists the working out of the basic facts about the plant life of the forests which are needed in the practice of forestry. In the same article Mr. Graves says: "If in the field of botany the forester has contributed to the progress of botanical geography, and in the realm of meteorology he has opened up new fields of investigation, his influence in wood technology has been in changing entirely the attitude of engineers, physicists, and chemists in the handling of wood products."

The reason engineers, physicists, and chemists had to depend upon

[5] Graves: The Place of Forestry among the Natural Sciences. Science, Vol. XLI, p. 117.

foresters to set them right in these problems must be ascribed to the difference in their previous training and to their consequently different viewpoints. The importance of viewpoint is often overlooked. That the civil engineer cannot deliver the goods needed in a logging camp unless he has had many years of practical experience was most forcibly brought out at the Pacific Logging Congress in Spokane in 1913.[6] The forest schools of the West had shown their ability to meet this situation and were particularly urged to extend their courses in logging engineering. The men from these forest schools have made good in this capacity after a surprisingly short period of apprenticeship, and that in the face of a prejudice developed against technical men because of the failure of the civil engineer in this work.

Very little of the technical work in wood preservation is being handled in a broad scientific manner in this country. It is chiefly in the hands of chemists, mechanical engineers, and so-called practical men. They have little knowledge of the structure of wood and practically none of decay. A few foresters have become interested in the work and their influence has been of tremendous value, even though they had practically no specialized university training in wood preservation. If we could stop here a moment to consider the really valuable and lasting contributions to the fields of work ordinarily referred to as the minor fields of forestry, such as logging engineering, wood preservation, timber testing, and in fact most of the work in forest products, it would be very evident that the men with the forest-school training have been delivering the goods. From the standpoint of results, it therefore seems quite evident that logging engineering and forest products are legitimate fields for the forest schools to develop, and furthermore that it is their duty to develop them, if these lines of work are to be placed on a really efficient basis in this country. If the forest schools have been able to get results from the meager, and from an educational standpoint inefficient, methods of teaching the minor lines, what will they not be able to produce if they will but develop these lines properly?

As suggested by the Forester, the work of the engineers, the botanists, physicists, and chemists has been on the wrong tack. The special training we have given our students along these lines has been meager, yet the foresters have been able to make good because their training has been broad *and their viewpoint different.*

From another standpoint, namely, that of university organization, these new lines of development in forestry belong to the forest schools.

[6] Proceedings, Pacific Logging Congress, 1913; George M. Cornwall, Sec'y, Portland, Ore.

The very fact that the other university departments have been unable to see the opportunities for development in these fields until pointed out to them by the foresters shows which of the departments bears the closer relation to them. Again, all the fundamental work of the first two years of the division, technically known as a college, is, in practically all Class I universities, either identical or very closely related. This is particularly true with reference to the technical divisions. The nature of the fundamental work is one of the most important factors used to determine the school or college to which any department belongs. On this basis the pure forestry work, as well as the so-called "secondary specialties," will not fit in with any of the old-established college divisions, and this probably explains why in the organization of the work in this country forestry has been variously placed in agricultural, engineering, and even the science and arts colleges, instead of into separate colleges or forest schools. To place the work of logging engineering or forest products on an efficient basis in any other division than that of forestry would mean an entire reorganization of those other departments from the ground up. On the other hand, all of the newer work developed by the forest schools can be fitted into the established forestry curriculum with only very slight modifications.

The foregoing points may be well illustrated by one example. An analysis of the work in wood preservation—a subject which might with some justification be claimed both by chemistry and by mechanical engineering—will readily show the investigator to which university department this work belongs. Preparation for any highly specialized technical subject can be divided into three periods: First, the general prerequisites; secondly, the special foundations, and finally the practical applications. In order to emphasize the relation of these various groups to one another, it will be necessary to discuss them in reverse order. The practical course in preservation should include the economic phases and relation to forest management; wood as a material for preservation; the physical, chemical, and toxic properties of preservatives; the methods of treatment, including a thorough study of apparatus, operation, and costs; the use of treated wood and methods of using it, and finally the business problems. The special foundations for this work must include the elementary technical forestry sciences, with special emphasis on wood technology, timber physics, wood utilization, and forest pathology; and the general prerequisites must cover the elements of botany, chemistry, physics, mechanics, steam engineering, and economics. Could such a course be given satisfactorily anywhere except in a forest school? The combination of subjects included in the *general* *prerequisites* and the *special foundation* is quite foreign to any other department, but fits in beautifully with the general make-up of the forestry curriculum. What has been shown here with reference to wood preservation can be shown with equal force to be true of any of the work in lumbering, logging engineering, and forest products, providing this work is to be placed on a broad scientific basis.

If now, on the other hand, we examine the ability of the forest schools, from the standpoint of equipment, either in the way of apparatus or instructors, to handle the advanced technical work, how many are fitted to prepare the ordinary student to become, after a short period of apprenticeship, a moving spirit for improvement in these industries? There may have been some excuse for this state of affairs along some lines of the work, because men with proper training to teach the subjects were not available. Nevertheless, it remains a fact that a number of highly specialized technical lines in forestry are not being developed to a desired and proper extent. This, together with the failure of the Forest Service to develop or, when it begins to develop, to hold men who should stand at the head of these professions in the land, undoubtedly is one of the reasons why the profession has not as yet gained the standing in the scientific and technical worlds that it should have gained. And we must recognize as a fact that it has not. Some of the most promising technical men the Service has had were easily induced to enter the employ of commercial organizations, where their scientific attitude of mind soon gave way to the commercial attitude. As a result their value to the profession materially diminished.

If we grant that it is proper for the forest schools to thoroughly develop the so-called "allied fields" of forestry, then we must also grant that there is no danger of overcrowding the profession. This has been most forcibly illustrated by the difficulty of getting men properly equipped to handle the work in timber inspection and kiln-drying in connection with the country's war needs along these lines. It is the first time that any attempt was made to apply on an extensive scale scientifically efficient methods of handling this work. Properly trained men were very scarce indeed, and at least until very recently much of this even was handled in the field by rule of thumb and guesswork methods, with practically no fundamental knowledge of the principles involved. It was only through the efforts of the products branch of the Service that any headway was made at all. The country over, these lines offer an opportunity for a large force of men. They are, moreover, only two of the many lines of work tying in with the forestry curriculum that are being handled in a makeshift fashion throughout our industries. However, in order to meet effectively the fields that should be open to the graduates, we shall have to place the work on the same basis of specialization as we have placed the work in silviculture and management, and supply the schools with satisfactory equipment both in the way of apparatus and instructors.

Another important problem in forestry education is the standard of graduate work. This likewise has left is mark on the standing of the profession. The advantages of having the early work in forestry in this country placed on the graduate basis is obvious. The newness of the work and the necessity of exercising a good deal of judgment in the early development of forestry called for men with maturer minds than ordinarily found in persons with only an undergraduate training. We must admit, however, that the work given was not of a graduate standard as measured in other technical schools of high standing, and that even to this day the work has not as yet fully attained this standard. It is particularly unfortunate that any school should thus far have offered the doctor's degree in forestry. Much of the work in the graduate schools is elementary in character when viewed from the graduate standard, and the work of the graduate schools will not have attained the real graduate standard until this elementary work is required for entrance. This problem, too, is solving itself after a fashion; but the process is slow, and unless greater effort is made to hasten it by the educators themselves it will drag along for years.

If we would place the graduate work on a high-class graduate basis, we must demand for entrance a broad, general undergraduate course, which will cover the necessary prerequisite sciences, languages, economics, and such work in technical forestry as is now being conducted satisfactorily in the undergraduate schools. Would it, for example, be possible for any one without a fairly broad training in chemistry, botany, economics, etc., to get into any of the graduate schools of high standing without a thorough foundation in these subjects, or into schools of law or medicine without pre-law or pre-medical courses? Of course, there will always be some necessary overlapping between the work of the two divisions; but what we should strive for is a clear demarcation between both the subject-matter and the grade of work in the graduate and the undergraduate schools. This will mean that the purely graduate forest schools shall have to depend upon the undergraduate schools for their students. It will also mean that some of the schools now offering graduate degrees will have to confine themselves to the undergraduate class, because the higher classes of work will succeed in the long run only if they command expensive equipment and the highest grade of instruction. Particularly is this true if the graduate work is to offer thorough opportunity for specialization, as it must. The idea of graduate work and specialization are inseparable; when we think of the one we think of the other.

There are some indications that the work of the graduate schools may in time be more or less differentiated. Thus, for example, Harvard is making a specialty of the "lumber business," and furthermore has in the Arnold Arboretum no competition in the form of a graduate laboratory for the study of dendrology. Yale has in the past furnished the majority of forest-school teachers, and is now taking up "tropical forestry" as a specialty, in which she will probably never have any real competition. At Washington we have for some time been specializing in "logging engineering" and "wood preservation." This whole problem will probably work itself out in time, as it has in other technical lines, with the result that the different schools will be especially attractive for students in certain specialized fields of work.

With a clear differentiation of the undergraduate and graduate work, the graduate schools should also be able to exert a wholesome influence on the undergraduate standard by controlling the quality of work they will accept for admission. On the other hand, we may be sure that the undergraduate schools will have a good influence upon those limiting themselves to graduate work, because there will always be some of the former of such high standard that they will prod the latter along in case they do not keep ahead of the game.

The system of specialization in various lines will demand a pretty free allowance of electives in the undergraduate courses, in order that the student may take the work of most advantage to him as prerequisites to his specialty. Would it not, for example, be far better that a student who intends to specialize in forest products be allowed to substitute more chemistry or mechanical engineering for the work in topographic surveying? Although we must guard our curriculum most carefully against a degeneration into the trade-school grade of work, a careful analysis of the various subjects in the light of the practical work the graduate is called upon to do shows that the curriculum can be much more thoroughly correlated with the work of the world than it has been in the past without any danger of lowering the standard.

By way of summary, it may be emphasized:

(1) That the legitimate field of the forest schools include all the work in lumbering, logging engineering, wood preservation, all phases of products work; in fact, all work pertaining to trees, forests, and forestry that ties in better and can be handled more advantageously in

connection with the forest-school curriculum than that of other university departments.

(2) That the colleges of engineering and agriculture and the departments of botany, chemistry, physics, etc., that have tried to enter these fields have made a comparative failure of it, *unless the work was handled by persons properly trained in forestry.*[7]

(3) That, taken collectively, the forest schools are not properly fulfilling all their functions unless they offer the same opportunities for specialization in the so-called "allied fields," *under conditions making for the same high standard of instruction,* as in silvicultural practice and forest management.

(4) That if the forest schools will train their students so as to cover the field as outlined in (1) above, there is no danger of overcrowding the profession for many years to come. In fact, there is a crying need for specialists along various lines which it will take many years to fill.

(5) That the term "forestry" has been too closely hedged in by its literal meaning. The technical specialists of high standard developed in the minor fields by the Forest Service and the forest schools are a distinct product of the development of forestry in this country and worthy of being recognized as professional foresters.

(6) That the graduate schools of forestry have not as yet reached the same standard as those of recognized high standing in other professions, and that they will not until a clear differentiation between the undergraduate and graduate work has been established.

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[7] The writer desires to emphasize that he does not include here institutions like Cornell and California, where the work in forestry, although grouped under the College of Agriculture, has been organized as distinct departments or divisions under the direction of foresters of recognized high professional standing.

THE FOREST SERVICE AND ITS MEN *

By H. H. Chapman

Part I

The Forest Service will stand or fall upon the question of whether it can maintain within its organization that high standard of ability and integrity which has given to it the confidence of the public, and through this fact alone has made its present tremendous task possible.

One thing only can undermine this confidence—failure to secure and to retain men with the character and ability to deliver the goods. The Forest Service demands *men*—men with initiative, experience, broad human sympathy, public spirit, and infinite capacity for taking pains. Such men are not found in the ranks of professional job hunters.

The Service is essentially an organization of *field men*, every one of whom, from the greenest ranger and fire guard to the men in the district office, must combine physical stamina with mental alertness. From the ranger, straight through to the supervisor, district officer, and Washington official, the Service requires men with the qualities not merely of good workmen but of leaders; and wherever in this organization the quality of leadership is lacking, we find the standard of performance falling short of our absolute requirements.

The Forest Service *is an organization of fighting men*, who have carried law and orderly progress through the length and breadth of the entire mountainous region of the West; have put an end to range wars; evolved a practical working system of Government business in place of the proverbial mass of red tape, and have accomplished the miracle of winning over to a grudging or a whole-hearted support the most independent and liberty-loving elements of our Commonwealth—the western miners, stockmen, pioneers and lumbermen, and the eastern mountaineers.

The problems of administration which the Service has to meet are those dealing with the vast resources embraced in over 150,000,000 acres of forested, mountainous *land*, and the use and renewal of those resources, whether they be timber, forage, water-power, protection of streams, fish and game, or scenic values and recreation. These prob-

* A contribution to the discussion of the paper on "The Technical Forester in National Forest Administration," Vol XVI, No. 2, Journal of Forestry.

lems are both immediate and far reaching. They contemplate not merely the utilization of the timber, but its replacement with young growth which may take 200 years to fully mature, and unless the Forest Service can solve the technical problems of forest reproduction and protection, its failure is just as pronounced as if it permitted the sheep and cattle ranges in its control to be ruined for all time, carrying with it the destruction of soil and of streams by erosion, through lack of proper regulations.

Primarily, the National Forests were created for the protection, use, and renewal of timber. That the proper solution of problems of timber production demands a knowledge of forestry, best and most quickly obtained by technical study, is a fact admitted even by the most obtuse. But that the entire force of men required to administer the vast and diverse interests of the National Forests require a full technical education for the proper performance of their duties is an absurdity which no one has ever had the hardihood to utter.

The founders of our National Forest system obtained their vision and faith through a technical knowledge of the possibilities of forest production, and, based on this knowledge, they took steps to provide a means of training men in this country in the same knowledge. The result was a development of forest schools, which struggled earnestly and successfully to build up a system of sound, practical education in the fundamentals of forest management, and turned out hundreds of clean, ambitious men who looked on forestry in Government service as a career.

What has been the result? Has the technical forester failed to make good? And are the demands of the Service such that he shows at a disadvantage compared with the man who has risen from the ranks, free from the handicaps of impractical theories and one-sided specialism? And is this question going to be settled by precipitating a controversy and drawing a line of cleavage which never existed and never will exist in the Forest Service between "technical" and "non-technical" men? The whole history and development of the organization belies the thought that its men have as a whole been either advanced or held back either because of their "book learning" or lack of it. One thing alone has determined advancement—ability to do the work and carry the responsibilities of the job, whatever it is. Those who have "been faithful in a few things" have literally been made "rulers of many cities," while those who have fallen down, regardless of whether they be cowpuncher or college graduate, have drifted away to other fields.

The writer is personally acquainted, in a fairly intimate way, with several hundred men in the Forest Service; and knowing them as individuals, with perhaps as clear an understanding of their traits of character and ability as any one person can hope to know of that mysterious complex termed personality, it has been possible to grasp the causes of their success or failure.

The first thing that stands out is that circumstances, environment, favoritism, and all that host of extraneous causes to which a young and inexperiencel man attaches so much importance have exercised a trivial and even negligible influence on the *final result* in almost every individual instance. Yet it would be idle to say that environment and the attitude of one's superiors are of no importance. It is probable that the marked success of men of real ability within the Service is due largely to the existence of the spirit of honor and fair play in the organization as a whole; otherwise the able men would get out, and their success, which is assured, would be attained in other lines. And in saying that the able men have succeeded, I do not say that they have all remained in the Forest Service as the road to success.

Those who have succeeded, either within or without the Service, have shown a remarkable similarity in the possession of certain traits, the description and analysis of which is attempted below.

1. *Integrity.*—This is apparently not only the most essential but the most common trait of these men. It means plain honesty, reliability, truthfulness, and clean habits. Immorality, intemperance, trickiness, and dishonesty, no matter how well veneered with ability and culture, have never gotten by for a very long period.

2. *Loyalty.*—It is a remarkable fact that cynicism, habitual knocking, and suspicion or jealousy are usually accompanied by irresponsibility, inefficiency, and narrowness of vision to such an extent as to render a man's services worthless, independent of his sentiments. The unfortunate victim of the mental habit of disloyalty always imagines that his failure is due to the hostility that his independence in thought and utterance arouse in his superiors; he becomes in his own mind a victim of persecution, and his final severance from the organization is usually automatic—he quits. Loyalty, on the other hand, is anything but slavish toadyism to one's superiors. Too often such a spirit only conceals one's contempt and disloyalty. Loyalty is the spirit which puts the organization and its ideals above the man; that seeks a proper knowledge of cause and effect; recognizes the absolute need of co-operation and discipline, but will not hesitate to incur disfavor if clearly necessary for the vital good of the Service. Loyalty and conformity are not synonymous, although often regarded so by incompetent superiors.

Criticism and suggestions for improvement are the life blood of an organization, and this fact is recognized by all progressive leaders.

3. *Ability.*—It is often thought that superior mental ability is the first quality for success; but experience shows that, unless founded on integrity and loyalty, a brilliant thinker is apt to become eccentric, cynical, and even immoral, ruining his career for lack of character. Only when combined with the stabilizing qualities which are equally the possession of the plodder does the brains of an able man count in the race; but *with* these qualities he succeeds in direct proportion to his mental endowments, whether these are the result of heredity, self-education, or training acquired in school and college. To just the extent that education improves a man's brain power and his mastery of his mind does it give him an advantage and a value not previously possessed.

4. *Energy.*—Laziness is a failing apt to be shared alike by the able and the stupid. It is equally fatal. Laziness is more deadly when mental than physical, though the two are closely related. Physical energy is a good sign, but sometimes is misdirected or even unconsciously substituted for mental energy. It is harder work to exercise the brain in mastering new problems or absorbing essential details than it is to exercise the legs. Mental energy means also the ability to stick at a job requiring routine and to secure accuracy. It calls for concentration and will power. Without it the tendency of the unfortunate individual is to shirk responsibility, which means that he will never be given promotions except as a matter of routine, and then grudgingly, for he is not fitted for them. Preference for narrow specialization is a manifestation of mental laziness. The individual refuses to make the effort involved in broadening out.

5. *Humanity.*—Since all human efforts are co-operative, the man who is most useful is the one who understands the other fellow best, for without this knowledge co-operation is impossible. Selfishness, no matter whether it is shown as self-conceit or egotism, self-concentration, or indifference to others, or self-indulgence, of which laziness and intemperance are examples, kills a large portion of a man's usefulness. Trouble follows him, misunderstandings are his ordinary daily fare, jealousy and suspicion a common frame of mind, and he is unable to grasp even the necessity for many useful lines of effort. The importance of the right attitude toward the individuals with whom the Service does business is entirely lost on him. The same inability to think about the other fellow renders him gullible, and usually he is cordially disliked.

On the other hand, the sincere desire to devote his energy to public service in its true sense opens one's eyes to true conditions, develops soundness of judgment, and gives the *quality of sympathetic understanding, which alone makes one a true leader of men.*

6. *Efficiency.*—The quality of efficiency may be compared with the work of a highly complicated machine, which delivers the maximum product without hitch or breakdown. Primarily, this quality demands the elimination of errors. An ordinary college education often fails in this, though engineering and mathematical training is peculiarly effective in securing it. Errors mean but one thing—lack of concentration on the task in hand. The wits go wool-gathering. The individual has never learned to harness his brain to work. With concentration and elimination of errors comes its corollary, memory, which gives one instant command of any situation or subject which has at any previous time received his attention. Energy is the fuel. With this added the result is certain.

7. *Co-ordination.*—Men may be tremendously efficient as individuals, but lack the power to delegate responsibility or authority. Such men should never rise higher than a one-man job. To be in charge of any large enterprise two qualities are essential—a thorough understanding of men, with command of their respect, and ability to grasp fundamentals in their relative importance and direct the energy of others along the most essential lines. No man can do this who is mentally lazy or who has not himself gained a large measure of experience in the lower ranks.

8. *Hardiness.*—The work of a forester demands a rugged physique and enjoyment of physical hardships; but it requires more than this. Mental ruggedness is hard to define, but none the less real. The environment of the forest officer, until he has won his spurs and attained a glimpse of the swivel chair, is not so much a matter of muscular fatigue and coarse food, makeshift beds, and exposure to heat and cold as it is a constant contact with men of a primitive cast of mind, elemental emotions, and childish whims, who often display complete lack of reasoning powers, coupled with vicious tendencies. Men who have been raised in hothouses, without experience either with ignorance or depravity, are slated for some rude jolts and may utterly fail to come through the "melting pot." Such men lack mental hardiness. The necessity of understanding the average character and impulses of the local residents is unquestioned, but the surest way to *lose* all respect and authority is to debase one's own standards of conduct and morality in order to assimilate local color and become solid with the public. Tolerance and license are two different things. The man who succeeds

is the one who keeps his own standards intact, while learning to allow for the weaknesses of others, and who can endure mental deprivations and hardships, not because he never knew anything better, but because he has sufficient mental resource to keep his thoughts occupied in a healthy manner in spite of his surroundings.

9. *Adaptability.*—The Forest Service demands men who are adaptable. In no other department of Government work are the demands upon one's capacities more varied. The cowpuncher who essays to hold the job of ranger finds himself called on to build barns and trails, organize fire-fighters, mark timber for a sawmill, scale logs, pass upon innumerable special use and claim cases, and get out creditable reports. The technical assistant is plunged into a maze of office and field work involving things he never heard of. The supervisor discovers some new problem every month.

It is not so much what a man knows when he enters the Service *as what he is able to learn* that counts. It would be impossible to cram the endless details of administration into the mind of the future employee by any process of schooling, for these things must be absorbed by doing them. Adaptability is the prime requisite for progress, and this means the capacity for absorbing knowledge and the willingness to make the effort. Here, again, the trained mind has all the advantage; and it is not a miracle that the men who have made the best administrators of grazing are not cowmen, but rank outsiders, some of them from eastern colleges, who brought to the study of the subject a fresh and unbiased mind and habits of systematic thought and observation.

10. *Initiative.*—The work of the Forest Service in the field is to a very large degree solitary. The ranger is alone on his domain of from 150,000 to 200,000 acres. The harried supervisor is in touch with him only by mail and telephone, with infrequent short inspections. It is up to him to go ahead, plan his own work, and carry it out. The same rule applies with even greater force to the supervisor, upon whose initiative and constructive ability rests the success of his administration. The man who merely "obeys orders" and will work only under the immediate direction of a superior is worthless for this Service. Division of responsibility demands the quality of iniative. Fortunately for the work, this quality is not rare among western men, and the ranger force has set a magnificent standard of achievement. But initiative is also demanded in research and in administrative problems beyond the grasp of the ranger. Education stimulates and develops initiative to a remarkable degree, and it is fair to say that the great bulk of Forest Service policies and achievements along untried lines of

administration has been due to the fertility of resource displayed by the leaders of the organization as well as its rank and file.

11. *Idealism.*—No man can be truly successful and remain so without a clear view of the goal for which he is striving; and if the aims of Forest administration have never been revealed to a man, or have been acquired by him solely from his own experience and observation, he will create his own set of ideals and will too often fall far short in his achievement. Here, again, the "practical" man is handicapped, both by what he knows and does not know. The great ideal toward which the Service works is the successful handling of the timber resource, not merely for its present exploitation, but for reproduction and establishment as a permanent asset in our national life. Obstacles to the achievement of this end loom large, and to the man without forestry training may not only seem unsurmountable, but often he never even sees beyond them nor is able to recognize the true goal. It is not, as he prides himself, that he has a better sense of values, based on the proper balance of the needs of the present and the future, but that by his training he is frequently unable even to see the future, much less to give it a proper weight in the scheme of things. An impractical theorist is impossible as an executive, but a man without ideals is as dangerous as an I. W. W. It takes a trained mind to make idealism practical; and unless the Forest Service is guided in its policies by just such men, there will come a time when the public will curse us out for betraying the trust imposed on us and failing to achieve the great purpose of our founders.

12. *Experience.*—No other argument is used so convincingly to prove the relative superiority of practical training gained in doing things over theoretical education obtained in the class-room as that whose basis is experience. The contempt of the practically trained man for the technical graduate fresh from school, who reveals some startling phase of ignorance in the handling of horses or makes some bad break through lack of familiarity with local custom, is unbounded, and the poor ignoramus is branded as a failure from then on. We find this contempt and intolerance as a common trait of those who work largely with their hands and whose horizon is narrow. Why?

To every man comes experience as the cumulative reward of effort, physical or mental. To the pioneer, the laborer, and the mechanic this takes the form of skill with animals, woodcraft, good artisanship, and other muscular training, in which he excels by habit. But there is another and far more important kind of experience—that of *mental observation* and reasoning—which the man who merely excels in doing things from habit often lacks entirely. He has not used his brain nor developed it. His knowledge is based on tradition and unreasoning acceptance of customs or common beliefs. He is the last to accept new notions or admit the possibility of doing things differently. Witness the scorn with which the average farmer of an early day greeted the efforts of the agricultural experiment stations.

If a man will *think* and observe and will correlate his observations, especially if he uses every opportunity to seek new fields of endeavor in an effort to broaden out, he is giving his brain an education and storing up *mental,* not merely muscular, experience. Men without schooling may thus by their mental vigor acquire experience in human nature, reasoning powers, and ability of a high order. This sort of experience is indispensable alike to the man who lacks or who possesses college training. But education, either technical or general, while it *does not* give a man this direct experience acquired by contact alone, does emphatically prepare his mind for the rapid acquisition of *both physical and mental experience.* The educated man is always seeking and getting new ideas. He constantly increases his powers of observation, comparison, and generalization until he reaches the state of development where a new environment is assimilated with remarkable ease and intuition supplements the slower process of reason. Trivial incidents supply to his trained powers true indications of conditions which he is seeking to learn. He is seldom swayed by false evidence or misled by circumstances and becomes sound in judgment and quick in execution. This ability to actually profit by experience is the most striking distinction between the trained and the untrained mind. *How* the training is obtained, whether in college or through one's own efforts and mental industry, *aided by travel,* is not important. As far as my observations go, the man who *first* acquires experience in the field before completing his studies makes the strongest man. He not only gets more out of his college work through knowing how he is to use it, but he is saved the setbacks resulting from inexperience. Education develops tolerance, and a man whose mind is trained will make allowances for the mistakes of others; but an uneducated mind tends toward intolerance and prejudice and refuses to admit the existence of any ability whatever in a man who has not acquired the same proficiency (without experience) in performing various mechanical stunts that the critic has had a lifetime to acquire. When the green man with an education is placed under the authority of the other, he is frequently discredited utterly. Hence the advantage of getting the rough edges worn smooth before acquiring the perilous reputation of "technical training."

But, given time for both, the one who has acquired both technical or theoretical knowledge of his profession and practical training, *no matter in which order they were mastered,* is usually superior in ability as an all-round, broad administrator to the man who has had only the practical experience, even though he has made the most of his opportunities, just as the latter is superior to the physically trained man who has not developed his mind at all. The weakness of the man without a broad education is that he constantly tends to confine his reasoning *to his own experience,* and it takes him too long to actually find out himself all the principles and facts which he needs. For instance, a certain official whose principal experience had been in grazing took the attitude that timber cruising was not a science and could be adequately performed by green men without competent direction. He himself had had no actual experience in timber cruising, but considered himself adequate to judge.

13. *Common Sense.*—Perhaps no quality is so difficult to define and yet so well understood as common sense. It represents the consensus of opinion of a man's associates that he is right instead of wrong on matters of common interest which make up daily life. For this reason one cannot be his own judge as to whether he possesses this quality.

Common sense is the concrete result of the normal development of mental powers by experience, observation, education, and reason. It is the ability to think straight, with no selfish twist or bias, and to reach intuitive conclusions whose sanity is at once evident to others, whether they agree or not. Since the essence of common sense is the comprehension of *common standards* of right and wrong, common human qualities and traits, and common ideals, no one who is not a student of human nature from the standpoint of sympathetic understanding rather than cynicism can ever hope to acquire common sense. It is the goal of the struggle for character, not inherited or "come by naturally," but acquired directly as the result of building up a balanced character—or as the concrete summing up of the traits of character previously analyzed in this article.

14. *Personality.*—Some people and some nations have tried to reduce human nature to terms of material facts and to measure human character with the yardstick of science and mathematics. It can't be done! The flaming spirit of man's immortal soul gives the lie to these gross materialists and will overthrow on the blood-soaked fields of France the damnable doctrine that character and right are non-existent because they cannot be analyzed in a chemical retort.

Personality is the intangible, but concrete, *mental force* and individuality which makes its presence felt by others without their realizing its source or analyzing its character. What is *not* commonly grasped is that personality is a result of forces controlled by the individual and is the expression of past experience and heredity. But, more than all else, it is the result of the struggle of one's inner consciousness to acquire character, the mental and spiritual efforts of the past years, the consciousness of power, based on achievement, and impressed without apparent intention on those with whom its possessor comes in contact! This is the inner spirit of man which defies the materialists—the domain, not of cold intellect, but of human individuality. Just as physical effort increases muscular strength, so every mental struggle to expand the horizon or strengthen the character reacts upon the mind to mold the personality into a form not only more capable of repeating these efforts but more powerful to influence others.

15. *Public Service.*—Public service is not confined to positions as public officials. It permeates every business and private activity. Civilization itself is founded on co-operative effort as contrasted with selfish appropriation. Selfishness is a survival of barbarism and tends to recreate barbaric conditions in which neither life, liberty, nor happiness is safe.

The individual who comes to realize that this law is fundamental and attunes himself to it, whether he is working for the Government or for a private corporation, will succeed. The organization which adopts it as its platform and goal will become established beyond fear of overthrow and will endure just so long as it holds to this ideal. The strength of the Forest Service lies wholly in the fact that its ideals are to give the greatest possible service, regardless of the personal inconvenience or hardship imposed on the organization and its men. To do this we must have men of the highest ideals, and must retain these men, that their experience may not be lost; for public service, to be effective, must combine willingness with ability and training, and no organization can measure up to its responsibilities in which the conditions imposed from above upon its men are such that they tend to seek other fields of employment.

Part II

We can now attempt to apply those standards of success to the technical graduate of a forest school. It is possible for me to discuss only the Yale Forest School, but the number of graduates of this institution who have been connected with the Forest Service, 247, is large enough to offer a safe basis of generalization. Furthermore, this is an eastern institution, and as such could be expected to suffer the maximum handicap in sending out men wholly unfamiliar with western conditions—the drawback upon which the most stress is laid. What success has been achieved by these Yale men *must therefore apply at least in equal measure to men from forest schools located farther west.*

Of the total, 247, there are now 126 men still in the Forest Service, or over 50 per cent. The average term of service of the entire number is 7 years, out of a possible 9.4 years, or 73 per cent of full service, the remaining 2.4 years representing the average period without the Service of those who have resigned. Since the chief question raised is as regards the ability of these men in administration and their power of adapting themselves to the demands of the organization rather than as technical specialists, their record must be analyzed with this in mind.

Time is an element in success. Position and responsibility is its most commonly accepted demonstration. On this basis these 126 men now in the Service can be graded as follows:

Successful in administration in western National Forests	56	
Successful in technical work in western National Forests	10	
Successful in administration in eastern National Forest work	12	
Successful in technical work in the eastern Forest Service	6	
Total established successfully		84
Certain to be successful in administration in western National Forests, but period of service too short to have achieved rank	19	
Certain to be successful in administration in eastern National Forests, but period of service too short to have achieved rank	6	
Total promising success		25
Total of both classes		109
Per cent of success	86	
Per cent in administration of those successful	77	
Not classed as successful		17
Total all classes		126

Of these seventeen, eleven are valuable men, whose services are esteemed, but who have not progressed at the rates comparable with the others, leaving six comparative, but by no means complete, failures.

Of those successful in administration in the West, we have:

Washington office, from West	2
District officers	18
Forest supervisors	33
Deputy supervisors	3
Total	56

None below this rank have been included. The ten successful technical men are either in investigative work in district offices, in addition to those above, or have excellent reputations for such work in individual forests.

The 19 men listed as promising in western administration are still below the rank of deputy supervisor, mainly because of shortness of service.

The eastern administrative list includes six in Washington and six in charge of areas in District 7. Six more are listed as promising merely because they have not attained the rank of supervisor. There is no doubt as to their ability.

When to this record is added that of the graduates of all other forest schools, the question as to the administrative capacity of the man who has a technical education is proved by the facts beyond further challenge.

But how about the "lost tribes of Israel"—the men who were once in the Forest Service but are not there now? Here is where we must turn, evidently, to analyze the percentage and causes of failure in Government service. In this case, also, the number of Yale Forest School men is sufficient from which to draw safe conclusions. The first of these conclusions is strikingly brought out by the following table, showing the number of men entering the Forest Service from each class of the Yale Forest School and the number and per cent still in the Service:

Year of graduation.	Total in class—grads. and non-grads.	Number entering Forest Service.	Per cent of total class entering Forest Service.	Number remaining in Forest Service at present.	Per cent of total possible service represented by length of actual service.[a]
1902......	9	4	44	0	47
1903......	20	13	65	6	65
1904......	37	24	65	9	63
1905......	36	22	61	8	73
1906......	34	16	47	10	86
1907......	36	18	50	8	80
1908......	38	23	60	13	79
1909......	34	18	53	10	80
1910......	41	26	63	17	85
1911......	61	34	56	19	80
1912......	47	20	43	10	70
1913......	21	7	33	4	78
1914......	26	11	43	4	40
1915......	14	4	28	2	[b]66
1916......	16	3	19	3	[b]100
1917......	25	4	16	3	[b]75
Total.....	495	247		126	

[a] Based on total number of years of actual service compared with maximum years of service possible had all men entering the Forest Service from the respective classes remained in it to the present. Military service not deducted.

[b] Number and length of service too short to indicate tendency.

This table indicates, first, that the conditions surrounding the earlier period of service down to 1913-1914 were such that an average of about 75 per cent of maximum service has been attained by those who entered the Forest Service in these years.

But in 1914 an alarming drop occurred, first, in the number of those entering the Service who remained in it (and this in spite of the short period of service, 4 years, in which to drop out) and, second, in the per cent of those who sought Government service, which dropped from an average of over 50 per cent to 16 per cent; so that for the last three years the school has ceased to be a real factor in supplying technical men for Government service.

If my information is correct, this tendency is also reflected in other forest schools, though possibly to a lesser extent in western schools and in schools giving an undergraduate or a ranger's course.

Before attempting to analyze the statistics of the 121 men who have dropped out of the Forest Service, the writer wishes to ask the indulgence of the reader, and especially of the men discussed. He lays no pretension to being gifted with superhuman wisdom, in the ability to decide who have been "successful" or "only moderately successful," or the real reasons therefor in each case. He can only give an approximation, and in order that the case may be presented stripped of all exaggeration or flattery, has thrown every doubtful case into the balance against the successful side. The men have been classed in. four groups:

1. Men who attained success in the Forest Service, as arbitrarily measured by rank and reputation, and who resigned to increase their opportunities, earning power, or freedom of action, 41. The present occupations of these 41 men are as follows:

Secretaries of associations	4
State foresters or deputies (Including two chiefs of Forest Service outside of the United States.)	7
Directors of forest schools and professors of forestry	12
Successful in private business	18
Total	41

These men before resigning were ranked as:

District foresters	2
Assistant district foresters	6
Others in district offices	7
Washington office	9
Forest supervisors	10
Deputy supervisors	1
Forest examiners	6
Total	41

2. Men of unquestioned ability, good reputation, and promise, who resigned *before* attaining "successful" rank, in order to increase their opportunities, earning power, or freedom of action, 23.

3. Men who were apparently unsuited temperamentally to the Forest Service, but who since resigning have increased their opportunities, earning power, and freedom of action, 21.

4. Men who were deficient, as measured by the demands of the Forest Service, and who have failed to materially increase their opportunities or earning power since resigning, 36.

Making a total of 121.

Per cent of those resigning who either had or were certain to succeed in the Forest Service, 53.

Per cent of total who have succeeded in other fields after apparent failure in the Service, 17.

Per cent of those who resigned from the Service, not included with the above, 30.

In running over these 36 men, whose full success is not admitted, there are 24 who are good average citizens, engaged in useful occupations and making a fair success when judged by ordinary standards. In this test the standard applied is *not* an *average*, but one which gauges the quality of *leadership of men*. Every man here listed as successful has shown and demonstrated his ability as a constructive leader. The qualities of leadership cannot be expected of all men. The astonishing thing is that *at least 70 per cent of those who resigned have shown it*.

There are two periods when men with ambition and unusual ability are tempted to resign from the Forest Service and seek other outlets for their powers. One is represented by the first group. It comes when a man has stayed with the game until his capacity has outgrown his earning power. Meanwhile, if he is married and is raising a family, his expenses increase, while his salary, beyond a certain point, remains stationary. The average supervisor receives about $2,000. When this condition becomes sufficiently evident, the individual is forced by his own self-respect to resign in order to realize on his earning power and do justice to his family.

Only the exceptional man, whose devotion to public service overweighs all considerations of personal and material welfare and whose family responsibilities can be put in second place, will stay by the game unless he has outside means. Bachelors are not under the same compulsion. Nor do we include those who have sunk so deep into the rut of officialdom that they have lost the courage to paddle their own canoe and would rather depend with certainty on the monthly pay check than face the terrors of economic competition.

But the most critical period comes at the start, after about two or three years at most of service at initial low salaries and on tasks which are apt of necessity to be largely routine. The ambitious man, *if he can see his way through,* will stick like grim death; but once convinced in his own mind that there is no future in the Forest Service compared with prospects outside—whether or not this impression is justified—he quits before he has undertaken family ties and incurred financial obligations. Failure to hold such men in the Service—and this is said advisedly, based on impartial knowledge of many men—is hardly ever to be attributed to lack of perseverance, endurance, or willingness to tackle whatever job is given them, or disgust with environment. With hardly a single exception these men have been equal to the situation. They have quit because they were *not convinced by their superiors* that the game was worth the candle, and the fault lies largely with the organization.

Proper leadership is the key to success in any organization—how much more so in one of this character. I have tried to set forth in Part I of this article the qualities demanded for such leadership, and in Part II the degree to which this standard has been attained by the technical graduates of *one* forest school, which is undoubtedly true in general for *all* forest schools giving a thorough course of training. On the basis of this record of facts, it must appear that technical forest education, instead of specializing men to the point of inefficiency, has the opposite effect, of fitting them for general administration to a remarkable degree. That there has been no deliberate discrimination by which technical men have been advanced merely because of that fact, but that men of all calibers have, by and large, risen solely on the basis of their ability, is a fact too well known to be challenged for an instant. It is a matter of profound indifference to the superior officer who is looking for men to carry responsibility, where they come from or what their previous training has been, provided they demonstrate their ability by their performance since entering the Service and have come through as far as they have been tested.

I fail to understand how such a question could ever be raised unless there is really a fundamental misconception of the function of education in general and technical forest training in particular. It is almost like arguing that any given ranger, supervisor, or district forester is more efficient and capable *without a special training than the same man would become if he added that training to his other qualities.* Such an argument is a plea against higher education and will not stand the test of facts. The mental training received in college, independent of the special lines, increases mental ability, unselfishness, or humanity, efficiency, and notably increases adaptability and initiative.

The special training in forestry, which is much broader than the apparent conception of this training held by some who should know better, adds tremendously to the man's efficiency, *not merely* along silvicultural lines, but in *all lines,* by improving his powers of concentration and memory and his grasp of underlying principles of forestry, including such practical subjects as improvements, grazing, and accounting. A college training is also an excellent school for the suppression of such traits as gullibility, self-conceit, and disloyalty, though to attain mental hardiness requires usually some outside experience, combined with good heredity and common sense.

Finally, the technical training gives a man practical idealism. Much has been said about impractical ideas inculcated in technical courses. Perhaps it is temerity for the writer to say that he has failed to discover them. The basic practical nature of the training given at these schools has stood the test of actual field experience. School training that seeks *only* to fit a man for his routine administrative duties is a waste of time. The vital training is in fundamentals, technical methods, and broad economic principles and relationships, which give *vision,* and through the creation of ideals lay the foundation for leadership.

The process by which the proportion of technical men in the Forest Service might be reduced is clear—that is:

1. Resignation after several years of service.
2. Resignation after brief service.
3. Failure to secure the man at all.

If there are influences at work which have changed the outlook for men in the Forest Service and made such employment less desirable than outside opportunities, all three of these factors tend to operate at the same time and the results may well be serious.

Men just entering the Service are profoundly affected by the qualities of leadership of their immediate superiors. When these superiors lack executive ability, as is evidenced by failure to get the best work out of the younger man and give him the greatest possible encouragement and best experience, it tends to drive him out of the Service. It is an unfortunate fact that a few supervisors, lacking technical training, have at times apparently taken a certain pleasure in assigning young technical men to unfamiliar tasks, without direction, in order to demonstrate their worthlessness and the futility of technical training. Supervisors who, though lacking this training, are in a true sense self-educated do not fall into this error, but give the technical greenhorn at least as much consideration as they would any other promising but inexperienced man, and usually bring them through to their mutual advantage. The man whose mind is really trained, whether in or out of school, is fair to all alike and will make the best use of every man in his organization, technical or non-technical.

But the discouragements encountered from the lack of executive efficiency in the individual official are not sufficient to account for the present conditions. This condition has always existed and hundreds of technical men have survived the ordeal. The trouble is far deeper rooted and more serious. It lies in the existence of the "statutory roll" for supervisors, rangers, and other permanent Forest officers, copied after the older bureaucratic forms of Government service. In Washington, also, are thousands of superannuated Government clerks, pensioners of Uncle Sam, living on meager salaries, without ambition, working at a very low standard of efficiency, and creating in the minds of Congressmen and others an impression which they in turn unconsciously tend to apply to all Government employees.

Within the last four years the Forest Service has, for lack of funds, appointed only 44 men to the grade of Forest Assistant, though the services of men of this type are needed now more than ever. No examination was given last year for this class of men. Hundreds of men are annually taken into the Service as rangers to replace losses by resignation; and technical men, after spending four years and exhausting their financial resources in obtaining an education, can still effect an entrance into the ranks by the same route as was open to them *before* they started on training, namely, by serving as fire guards or laborers for six months to a year to establish local residence, taking the ranger examination, serving a probational period as ranger for another year at $1,100 in one of the statutory positions, in which they may remain indefinitely, until vacancies are created above by resignation or promotion. These uncertainties of status and prospect, and *not at all the character of their duties,* deter such men from tackling the work.

In the rural districts of New England the more ambitious men went West, until the residue fell far below the average in ability. The loss of the more able leaders, who in the past have been drawn to the Forest Service by the inspiration of the work and its great prospects, will have the same effect upon this service; and its chiefs are powerless to prevent this deterioration unless Congress is aroused to the danger and convinced of the need for a more elastic and progressive policy of dealing with the personnel. The tremendous impetus of the early days of the Forest Service and its clean standards and lofty ideals still carry it strongly forward in the race. Will this energy and efficiency be held, or is it to be slowly dissipated by a smothering weight of ancient governmental tradition and bureaucracy? Upon the answer depends in a vital manner the welfare and prosperity of hundreds of thousands of citizens of our great West and the proper conservation of an untold wealth of resources in timber, forage, and land. The war has but served to emphasize both the importance of these resources to the country and the insistent need of men who can meet the standard required.

COMMENTS ON KNEIPP'S PAPER, "THE TECHNICAL FORESTER IN NATIONAL FOREST ADMINISTRATION"

By Arthur C. Ringland

It is to be hoped that there will be general agreement with Professor Toumey's statement that a discussion of the relative effectiveness af the work of non-technical men as compared with those of technical training is "hardly worth controversy." What constructive purpose would such a discussion serve? It would tend inevitably to open a breach which most of us have considered closed years ago—closed by the mutual respect engendered by intimate contact in a common cause.

Why not discuss the deeper and more worth-while problem of how to make the work of forest officers as a whole more effective, regardless of whether they are damned or blessed with a degree? One fair comparison may be drawn at the outset between men of technical and non-technical training and newly appointed to the Service. It may be fairly said that the technically trained man lacks *experience* and the non-technical man *vision*. The problem is to develop officers of experience and vision from the material available.

As a district forester the problem of newly assigned men was no little source of worry. It did not seem enough to immediately detail newly appointed Forest Assistant Smith as technical assistant on a National Forest perhaps to serve under an unsympathetic forest supervisor; nor did it seem for the best interests of the Service to "turn loose" newly appointed Forest Ranger Jones, even though armed with such a formidable weapon as the National Forest Manual. It was this problem that gave rise in 1909 to the Fort Valley Ranger School on the Coconino National Forest in Arizona—the first school of its kind, I believe, on the National Forests. This school, while heartily endorsed by the Forester, was unfortunately abandoned for reasons of departmental policy—reasons which it is to be hoped now no longer exist. And here a wide-spread and erroneous impression should be corrected. The Fort Valley School was not abandoned for legal reasons. Mr. McCabe, the then Solicitor for the Department of Agriculture, made a clean-cut distinction in his decision between the legality of this school and the sending of forest officers to the University of Montana.

Contact with the Army, now for one year, strengthens the conviction that the Forest Service needs schools of practical application on the National Forests. The Army absorbs men of all degrees of training, but quite regardless of this all go through a school of application for nearly every branch of the service—combatant and non-combatant. I do not refer to the R. O. T. C. in the States, but to the schools of instruction behind the lines of the A. E. F. These schools under field conditions train the staff officer as well as the company cook in the objective of all warfare—the defeat of the enemy.

We should recognize that the newly graduated forest-school student is not immediately competent for duty as a National Forest officer and neither is a cowpuncher. What they both sorely need is a short training course in the every-day problems of a National Forest under the leadership of an experienced and sympathetic forest supervisor and his trained assistants before they assume independent functions as Forest officers.

Is it not wholly practicable as well as legal for the Forest Service to adopt the uniform policy of detailing new appointees, whether forest assistant or forest rangers, to a school of application to be maintained in each district? There need not be a formal school. It will be quite sufficient to select a typical National Forest in each district—such as the Coconino in District 3—a Forest that offers a field in immediate problems in timber sales, grazing, lands, engineering, and fire protection. Then see to it that such Forests are officered by men of experience, vision, and sympathy to permit them to efficiently serve as instructors to the probationers. Here let the inexperienced technical man and the non-technical man of little vision serve their probationary periods or a part thereof before being assigned to independent duty on the National Forests. Let them rub elbows and build up traditions and *esprit de corps,* and let them learn in a sympathetic atmosphere, as first-hand assistants to the experienced forest officers, how to meet the problems that will face them when they must act alone—the location and building of trails and roads, marking and scaling of timber, the handling of live stock, etc. The end of this period should determine the fitness of the student—whether for the so-called administrative work, for specialized service, or for the "green slip."

If these practical schools of application are established they would not cost as much as ranger or supervisor meetings and would be of infinitely greater value. The man with the sheepskin will know something of sheep and the man without horn-rimmed spectacles will not be without vision!

Kneipp fears that idealism in the Service has been or may be unduly emphasized. The Forest Service was the result of the idealism and vision of a few men and is maintained today by men of the same stamp. Those of us who have seen the wonderful and inspiring work of the French foresters well know what steady progress toward an ideal can do. Idealism and vision have made it possible for France to supply the armies of the Allies with indispensable wood products—products not slashed out of virgin forests, but from man-made forests grown through the painstaking efforts of generations of forward-looking men. This monumental work would never have been accomplished had the French Forest Service personnel been made up of men who merely saw the day's task. The technical foresters, rangers, and lumbermen alike of the A. E. F. will march home with a new conception, for they have seen the results of practical idealism.

Just a word as to the social aspects of this problem of personnel. If, as Kneipp states, the percentage of technically trained men is decreasing in the Service, it suggests a study of ways and means to make the conditions of employment more attractive rather than to lower our standards. Here is food for discussion!

By R. W. Ayres

The articles by Mr. Kneipp and Professors Toumey and Spring in the February number of the Journal of Forestry are of great interest to me, as, no doubt, they have proved to many other forest-school graduates in the Forest Service. These same questions have caused me considerable thought, because I have been a forest assistant and for ten years have had charge of a National Forest, and have seen four new forest assistants come and go while I have been a supervisor. My experience is limited to one Forest and my knowledge to District 5, but I am taking the opportunity to express my views on this subject in the hope that they may be of some value in solving the problem.

What is the matter with the forest-school graduate? That is—in effect—what Mr. Kneipp asks in his article, although he speaks of them as "technical" men, which is hardly correct, as we have men from technical schools in the organization who were not educated to be foresters. Furthermore, it seems that Kneipp confines his question to forest-school men on the National Forests only, and is not concerned with the careers of those who have gone into State or private work or who are in the district or Washington offices. I believe Kneipp is right, allowing for certain conditions in his district, and cannot see that the professors have answered him satisfactorily. But it is better for them to see that they cannot evade the question, and must face it squarely; otherwise the future of the forest schools, as far as the

Forest Service is concerned, is very questionable, and conversely the future development of the National Forest along scientific lines depends upon the attitude of the schools.

Professor Toumey asks for statistics, and so I have gone back to the records of District 5 and have taken January, 1909, because that was soon after the district had been established; January, 1913, four years later, and January, 1917, another four-year interval, which brings us to what was the normal pre-war conditions. A record now would be considerably different, showing a marked decrease in forest assistants and examiners. In fact, there are only five left out of the eleven of a year ago, and one forest-school supervisor has resigned and one has gone to war. It is a decrease which will not be made up for years, because the supply has now been practically stopped at its source by student enlistments from the different colleges.

District 5.	Technical supervisors.	Non-tech. supervisors.	Technical deputy supervisors.	Non-tech. deputy supervisors.	Forest examiners and forest assistants.
January, 1909....	2	16	2	7	6
January, 1913....	8	11	5	6	20
January, 1917....	11	7	0	7	11

The first two columns seem to bear out Toumey's and Spring's contention as to the value of forest-school men in administrative positions and warrant their optimism. But the next two columns show that forest-school deputies have disappeared entirely, leaving only a reserve of non-technical men to draw upon to fill the future vacancies in supervisor positions. This is apparently assuring a return of the non-technical man in those places if the ordinary procedure in choosing supervisors from the ranks of deputies is followed. But most serious of all is the decline in number of the forest examiners and forest assistants in the past four years. As already stated, the number, both in the field and in the district offices, is much smaller since war was declared.

If the number of forest-school men does not at least remain permanent, there may be several things wrong. The new forest-school graduate may not receive from supervisors the proper handling to bring him out and develop him; or he may be the wrong type of man for natural forest work; or he may not have had the proper training to fit him for such work; or the trouble may be a combination of these things. No one will deny that there is a need of trained and educated men in forestry as in other professions; so it cannot be that the Forest Service deliberately chooses to ignore them.

In 1909 the administrative officers on the Forests in District 5, including supervisors, deputies, and forest examiners, were 30 per cent forest-school graduates and 70 per cent non-technical; in 1913 the forest-school graduates were 66 per cent and the others 34 per cent; in 1917 the forest-school graduates were 61 per cent and the others 39 per cent. No doubt a census taken three years from now will show a much greater decrease of the forest-school graduates as compared to the non-technical men.

Since I have been supervisor four graduates have started their careers as forest assistants on this Forest; two are still with us, one a supervisor and one a forest examiner. I have noticed that the graduates are of two broad divisions—those who dislike scientific research or specialization and those who take to it naturally; the first class tends towards the specialized and purely technical positions. But the fact remains that every graduate is given a drilling in the theoretical and technical and only a smattering of the problems of administrative work, which he must pick up as best he can, once he is on a National Forest.

What we are talking about is a graduate who can make good in any line of work on a Forest and who will be able to realize on his investment in a technical education when it comes to being a supervisor or forest administrator. This is not a problem which can be thrown onto forest schools by the Forest Service regardlessly. Probably both are to blame for the results, and it is their joint responsibility to correct the mistakes of the past and to prepare for the new generation of foresters which will appear when world conditions settle down to normal. Without Forest Service activities the schools would lack their chief field of demonstration and experience, and without the schools the Service would remain where it was in the Land Office days, as far as forestry is concerned. If it is true—and I am sure it is—that an undergraduate can soon learn whether or not he is better fitted for general forest business or administration than for the scientific work, he should be given one year as a guard on the Forests before he is allowed to qualify for the civil-service examination; or perhaps he should spend a year or so on a Forest before he even enters a school, to see whether or not he is adapted for the life and the work and become thoroughly acquainted with the hardships and other disadvantages mentioned by Kneipp. And the Service should make it part of its business to take these future students or forest assistants and test them out by actual work, and by a study of their personalities and tastes help the schools to determine for what class of work they are best fitted. If this were done, fewer men would choose the wrong career, and both the schools and the Service would gain. Two men went from this Forest to forest schools; both had had a year or so as guard and on timber-survey work. When they settled down to class work they were like veterans compared to the rest of the class, and both were picked out for instructors. This shows what a little practical experience will do. And this idea, carried out in co-operation between the Service and the schools, is what seems to be the only solution of the problem; it will never be solved by implied accusations and bristling theoretical defense. It is a national question deserving the careful consideration of the entire profession.

THE RELATION BETWEEN SPRING PRECIPITATION AND HEIGHT GROWTH OF WESTERN YELLOW-PINE SAPLINGS IN ARIZONA

By G. A. Pearson

Forest Examiner, Fort Valley Experiment Station

An unusual opportunity for correlating plant activity with factors of the habitat under field conditions is afforded by young growth of western yellow pine (*Pinus ponderosa*, var. *scopulorum*, Engelm.) at the Fort Valley Experiment Station, near Flagstaff, Arizona. Individual saplings have been observed to exhibit a marked variation in height growth from year to year. This variation is especially conspicuous for the three years 1915, 1916, and 1917. In 1915 the growth was abnormally great, in 1916 there was a decided falling off, but in 1917 it rose again to about the same level as in 1915. Thus we find the prevailing occurrence of a short internode, representing 1916 growth, separating two unusually long internodes, representing the growth for 1915 and 1917.

Measurements were secured on 95 saplings, 5 to 8 feet tall, within one-half mile of the Experiment Station. The area is practically level and is typical of the mesa type of pine forest in this region. Logging operations some 20 years ago removed the bulk of the timber, leaving an open stand of mostly immature trees. Young growth occurs mainly in groups in the openings. These groups are rarely so dense as to result in excessive competition for light and moisture; in fact, they are usually so open that every individual receives practically full sunlight. The measurements determine the length of each internode, or the distance between whorls of branches on the main stem. Since an internode represents a year's height growth, the year corresponding to each internode is readily ascertained. An effort was made to secure measurements for 9 consecutive years, representing the period covered by meteorological records at the station. This proved to be difficult, because few saplings show uninterrupted growth during the entire period on account of injuries and other abnormalities. As far as possible all the saplings between 5 and 8 feet high in each group were taken, but for the reason just stated many had to be rejected. The 5 to 8 feet height class was chosen mainly as a matter of expediency, since this is the prevailing height of young growth on the area. Saplings of this height are about 25 years of age.

Attempts to measure the effect of physical factors upon growth under field conditions are usually complicated by the fact that several more or less interdependent variables, some of which cannot be satisfactorily measured, must be dealt with. It is often possible, however, to select one controlling factor which, because of its extreme variability or because it is prevailingly at a minimum, dominates the habitat as far as the success or failure of certain plants is concerned. The study at hand is simplified by the fact that we are not comparing different sites, but conditions on the same site in different years. It is evident, therefore, that one important factor—that of soil composition and texture—remains constant and may thus be eliminated. The variables demanding consideration are, in the probable order of importance, moisture, heat, light, and biotic factors.

MOISTURE

An analysis of climatic conditions immediately suggests moisture as the dominant factor in the problem before us. Moisture is the most critical factor for yellow pine in this region, and it is also the factor which is subject to the greatest fluctuations. The moisture supply in the locality of this study rarely falls so low as to endanger the existence of yellow pine, once it is well established; but moisture may be expected to exert a marked effect upon growth. Douglass[1] has shown that the width of the annual rings of yellow pine in the Southwest is a very reliable index of rainfall. It is also a matter of common knowledge among foresters that in young trees height growth is a more sensitive indicator of site quality than is diameter growth.

The most satisfactory expression of moisture conditions is to be found in available soil moisture, or, still better, the ratio between evaporation and available soil moisture, as proposed by Fuller.[2] Unfortunately neither of these factors can be used, because continuous records of soil moisture are not available. In the absence of better moisture data, precipitation records have been employed.

Annual height growth and precipitation for various periods of the year are shown graphically in figure 1. These graphs indicate spring precipitation as the controlling factor. Contrary to what might be ex-

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[1] Douglass, A. E.: Bulletin of the American Geographical Society, Vol. XLVI, No. 5, 1914.

[2] Fuller, Geo. D.: "Evaporation and Soil Moisture in Relation to Succession of Plant Associations." Botanical Gazette, 59, pp. 193-234, 1914.

pected, there is no apparent relation between height growth and annual precipitation, summer precipitation or winter precipitation; in fact, the growth from year to year often varies inversely with the precipitation for any of these periods. When it is considered that of the total annual precipitation at Fort Valley, the mean amounting to about 23 inches, approximately 40 per cent comes during the winter months (December-March), 30 per cent during July and August, and less than 10 per cent during the spring months (April and May), the foregoing statements are startling.

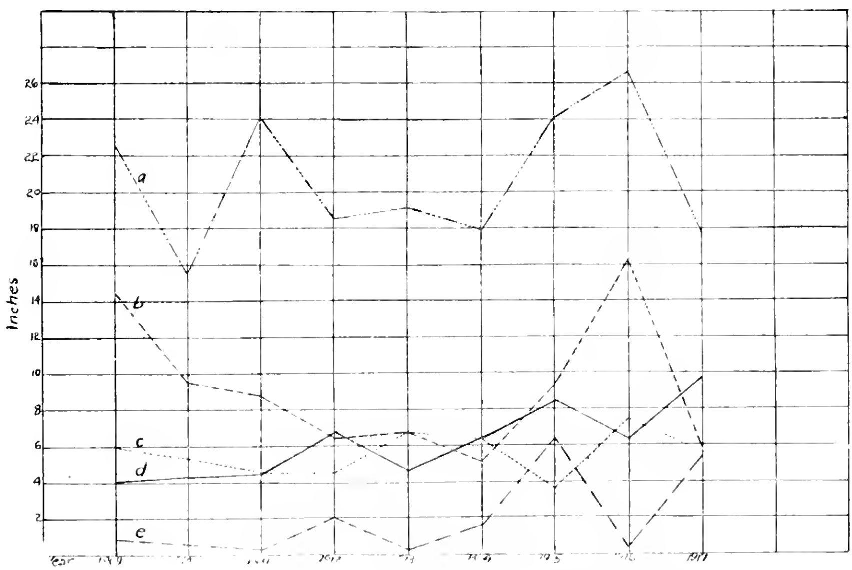

FIGURE 1.—Seasonal precipitation and annual height growth of western yellow pine saplings from 1909 to 1917. *a*, Annual precipitation; *b*, Winter precipitation (December–March preceding the corresponding year's growth); *c*, Summer (July–August) precipitation; *d*, Annual height growth; *e*, Spring (April–May) precipitation.

In order to clarify the problem, it is necessary to analyze the growth habits of western yellow pine as well as the climatic and soil conditions under which it grows in this locality. The terminal shoots begin to elongate about the middle of May, and by July 1 they have practically completed their growth. Thus it appears that the entire height growth occurs during the period of lowest precipitation of the year. From the middle of May to the middle of July the rainfall is normally less than one-half inch, and comes in such small showers as to be of no benefit to deep-rooted plants. It is evident, therefore, that the moisture utilized in making this growth is drawn almost entirely from a stored supply. It is also evident that the midsummer rainfall, since it does not begin until July, when height growth has practically ceased, is of little or no consequence, as far as the current year's height growth is concerned.

The water storage which makes growth possible is mainly the result of the preceding winter's precipitation; but it is the supplementary supply in April and May which determines whether the growth is to be above or below normal. Records at the Fort Valley Experiment Station covering the nine years from 1909 to 1917, inclusive, show a mean precipitation of about 8 inches for the winter months, from December 1 to March 31. The greatest amount recorded for this season is 16.3 inches, in 1915-16, and the lowest 5.1 inches, in 1913-14. The great bulk of this comes in the form of snow, which often accumulates to a depth of 3 to 4 feet, representing a water equivalent of 6 to 8 inches on the ground at one time. In some years the snow melts more or less through the winter, as a result of temporary thaws or rains, and then the accumulation is considerably below the above figures. Usually the snow is all gone by April 1, and the soil at that time is saturated to a depth of several feet. The penetration depends upon the rapidity of thawing and upon the depth of frost in the ground. Usually the snow goes off with a rush, and if the accumulation is large a considerable portion of the water is lost as run-off. It follows, therefore, that the heaviest snowfalls do not necessarily result in the greatest storage of soil moisture. Observations during the past nine years have shown that even in years of lowest winter precipitation moisture penetrates below the deepest tree roots. Unfortunately a continuous series of deep-soil moisture determinations is not available, but observations made in connection with excavations for improvement work have shown a high moisture content down to 6 feet or more. The following table gives the moisture content at 1 foot intervals down to a depth of 7 feet on June 6, 1913. The precipitation of the preceding winter was 6.67 inches, or about 1 inch below normal, while for April and May it was only 0.09 of an inch. Applying the given wilting coefficient, the moisture available to trees at 1 and 2 feet is 6.5 per cent, which figure probably holds approximately for the lower strata.

The stored supply of moisture indicated by the tables would probably be ample if it were all within reach of the tree roots, but this is not the case. Mature trees in this region rarely send their roots down more than 4 feet, while often the depth is less. The average 3-year-old seedling has a root only 10.5 inches long. Examinations of 6 of the saplings in this study showed that their tap roots extended to depths varying from 15 to 30 inches, and that the strongest laterals were generally within 1 foot of the surface.

Depth, feet.	Character of soil.	Moisture content, per cent dry weight, June 6, '13.	Wilting* coefficient, per cent.	Water-holding* capacity, per cent.
1	Clayey loam, mixed with volcanic rock fragments	19.2	12.7	63.5
2	Loamy clay (adobe) mixed with rock fragments and volcanic cinders	21.3	14.8	72.1
3	Adobe clay mixed with rock fragments	19.7	....	....
4	Adobe clay mixed with rock fragments and volcanic cinders	21.0	....	....
5	Adobe clay mixed with rock fragments and volcanic cinders	24.6	....	....
6	Adobe clay mixed with rock fragments and volcanic cinders	24.9	....	....
7	Adobe clay mixed with rock fragments and volcanic cinders	26.7	....	....

*From samples on near-by plots.

It is evident from the precipitation figures for 1913 that the pines in that year depended entirely upon winter precipitation for their height growth. Since the total precipitation in April, May, and June was only 0.25 inch, it may be readily seen that an addition of 2 or 3 inches during this period would have resulted in an appreciable increase in soil moisture and presumably in height growth. Such was the case in 1914 and in a more marked degree in 1915 and 1917.

If, as is often the case, the first of April marks the end of the season's storms, a dry period of 3 months prior to the beginning of the summer rains may be expected. Since yellow pine, on account of the low temperature, does not begin growth until about the middle of May, a dry period of 6 weeks intervenes between the last storm or the disappearance of snow and the beginning of growth. During this period a large portion of the stored moisture supply is dissipated without benefit to the tree. If, on the other hand, belated storms continue through April and into May, the stored water supply is not only conserved, but may be actually augmented. A typical example of the first type of spring was in 1916. Despite a winter precipitation of over 16 inches, the highest on record in 9 years, soil moisture conditions, after it became warm enough for growth, were decidedly below normal. This condition was indicated not only by the poor growth of natural reproduction, but also by the poor success of planting. The years 1915 and 1917 are examples of the second type of spring. The winter precipitation was only 9.4 inches in 1914-15 and 6.1 inches in 1916-17, but in both years the precipitation between April 1 and May 15 was around 6 inches. As a result, the growth of saplings was above normal and plantings were very successful.

It will be noted that the growth curve, while fluctuating from year to year, has a gradual upward trend from 1909 to 1917. This is due partly to the high precipitation in the springs of 1915 and 1917, but mainly to the fact that the growth rate of yellow-pine saplings normally increases with age. For this reason it would not be fair to compare the growth in 1909 with that of 1917 without making allowance for this increased growth rate. In recognition of this, among other factors, the saplings measured were selected as nearly as possible from a single age class of about 25 years.

The slight divergence between the growth curve and the spring precipitation curve in 1909-11 is accounted for by several circumstances. The decline in spring precipitation may be disregarded, since the amount in any year, being less than 1 inch, is too small to have any appreciable effect. Any retarding influence exercised by the slight decrease in precipitation is more than offset by the normal tendency of the saplings to increase their growth rate with age. This tendency is further augmented by another condition. As explained under "Biotic Factors," the saplings were seriously injured by grazing prior to 1909. In the fall of 1908 almost every sapling was broken, bruised, or partially defoliated. Observations at this time indicated that this condition had prevailed for several years, and that the plants were in a subnormal state of vitality due to a reduction of leaf surface. After grazing animals were excluded the foliage began to increase, and the response is reflected in increased height growth.

The precipitation for June has been omitted because normally it is a negligible quantity. An exception to the rule occurs in 1914, when the amount recorded for June is 1.22 inches. Undoubtedly the June precipitation played an important rôle in the increase of growth during this year.

A further correlation of height growth with moisture is found in the records of evaporation, relative humidity, wind movement, length of rainless period, and number of prevailingly cloudy days in April, May, and June. All of the above factors are a more or less accurate index of atmospheric moisture conditions. Evaporation may be regarded as the product of all the other factors mentioned, in addition to temperature. The graphs for these factors (figure 2) show a general, though not entirely consistent, relation to one another and to height growth. A notable exception to the rule is found in the trend of the graphs from 1914 to 1915. Both growth and precipitation show a pronounced rise, but the other moisture factors, with the exception of length of rainless period, show a decline. A plausible explanation for this discrepancy

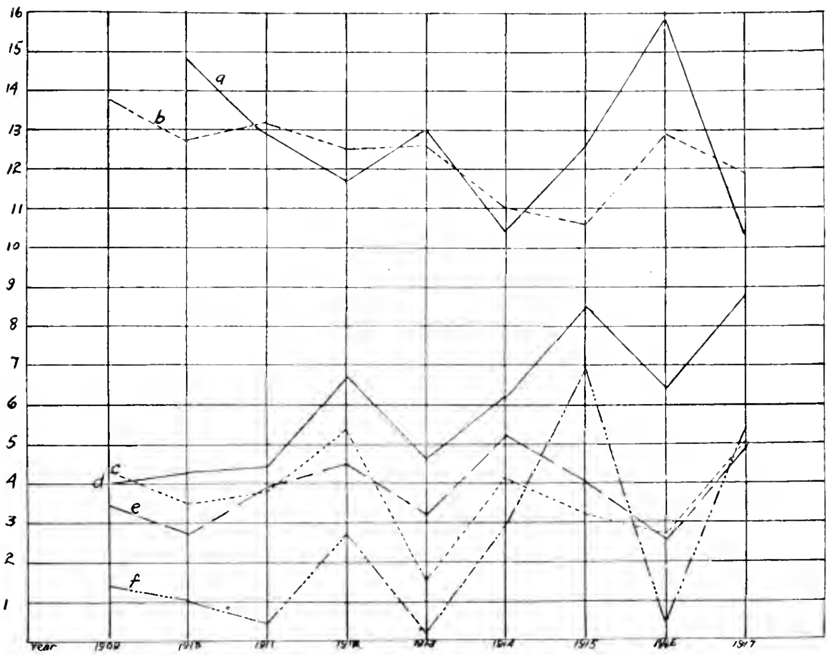

FIGURE 2.—Factors affecting atmospheric moisture as related to height growth of western yellow pine saplings. *a*, Evaporation from free water surface, total inches, May–June (records for April not available); *b*, Wind movement, mean miles per day ÷ 10, April–June; *c*, Number of prevailing cloudy days ÷ 10, April–June; *d*, Annual height growth, inches; *e*, Relative humidity, mean daily per cent ÷ 10, May–June; *f*, Precipitation, April–June, inches.

is that although the influence of evaporation, wind, relative humidity, and number of cloudy days in 1915 was to intensify drought conditions, this influence was counterbalanced by the extremely heavy rainfall of April and May; in other words, while evaporation in June and the latter half of May, 1915, indicates a high water loss, the soil was so well saturated as a result of the heavy precipitation during the preceding six weeks that the loss by evaporation could be borne without retarding tree growth.

HEAT

Graphs of height growth and mean air temperature for different periods are presented in figure 3. It is recognized that a better expression of temperature would be furnished by the product of duration and intensity of efficient temperatures. Since, however, the limits of efficient temperature, as far as yellow pine is concerned, have not been established, it is felt that little would be gained by such summations. Moreover, the mean temperatures, which may be safely taken as a rough

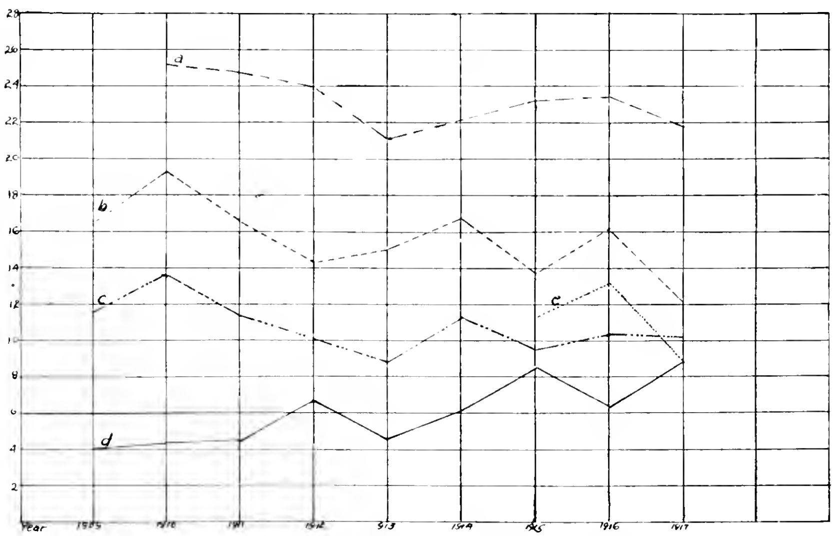

FIGURE 3.—Seasonal air and soil temperature in relation to height growth of western yellow pine saplings. All temperatures in degrees F. above 32. *a*, Mean air temperature, July–October; *b*, Mean air temperature, April–June; *c*, Annual air temperature; *d*, Annual height growth; *e*, Mean soil temperature at 2 feet depth, May–June.

index, show that air temperature plays a subordinate rôle in the problem at hand. The only really satisfactory expression of temperature is a measure of the heat absorbed by the plant—data which unfortunately are not readily obtainable.

The July-October temperatures are for the year preceding the growth with which they are correlated. Since height growth is completed by July 1, it is evident that the temperature after that date could have no effect upon the current year's height growth. It might, however, affect the height growth of the following spring. The storage of carbohydrates during the after-summer and autumn, for use in the period of greatest vegetative activity the following spring, is quite universal in trees and other perennials. Nevertheless, no constant relation between height growth and July-October temperatures is in evidence. The same is true, though in a lesser degree, of mean annual temperature, whether it be correlated with the height growth of the current or the following season. A more constant relation is shown by the April-June temperature, which, with some exceptions, varies inversely with height growth. In other words, maximum growth is recorded in the years of lowest temperature. From this it might be inferred that the temperature in this region is normally too high for the best development of yellow pine. Other facts at hand contradict such a conclusion. Recent investigations in the San Francisco Mountains indicate that the upward extension of western yellow pine is limited by low temperature, and that the mean temperature just below the upper limit of the species is only 2 or 3° F. below that at Fort Valley. Western yellow pine thrives in the southern parts of Arizona and New Mexico, where the mean temperature is 10 to 15° F. higher than at Fort Valley, providing that the water supply is sufficient. In fact, where the tree occurs under such conditions, under cultivation or along watercourses, it grows much more rapidly than it does at Fort Valley. The preponderance of evidence, therefore, supports the opinion that the temperature conditions at Fort Valley are nearer the minimum than the maximum for western yellow pine.

The apparently contradictory sets of data presented in the preceding paragraph may be harmonized in the following manner. Whatever deleterious effect is produced by high temperature is the result of the influence of temperature upon water relations. As long as the tree can secure enough water from the soil to replace the loss from transpiration, growth will increase with temperature up to a point far beyond any temperatures recorded in this locality. If, however, the moisture supply is deficient, then only a portion of the available heat energy can be utilized, and the surplus becomes injurious, in that it tends to increase evaporation from the soil and the transpiration rate beyond the capacity of the roots to restore the water loss.

As a rule, the years of highest temperature for the April-June period are also the years of lowest rainfall and highest evaporation. The only exception to this rule was in 1914. Thus, when the heat available for plant growth is greatest, it cannot be used for lack of sufficient water. In this respect the plant may be likened to a steam-engine. Given sufficient water, the power of the engine increases with the heat supply; but an increase of heat is associated with increased water consumption, and if water is deficient the engine cannot operate to its maximum capacity, regardless of the heat supply.

LIGHT

Continuous records of light intensity are not available. Since, however, the saplings concerned in this study are exposed to practically full sunlight, which is generally abundant in this region, and since they do not stand close enough to shade one another appreciably, it is not believed that variations in light intensity would affect annual height growth in any measurable degree.

BIOTIC FACTORS

Under biotic factors may be included fungous diseases, insect attacks, and damage by grazing animals. The trees considered in this study have been under close observation since 1909, and are known not to have suffered appreciably from any disease during this period. They have, however, been subjected to sporadic injuries by the tip moth, an insect which kills the terminal shoots, and thus destroys all or a portion of the year's growth. Such injuries may be readily detected by the appearance of the stem several years after they were inflicted. Trees showing evidence of tip-moth work or other abnormalities have been eliminated from the study. There has been no defoliation by insects during the period considered. Prior to 1909, the saplings, which were then mostly below 4 feet in height, were subject to severe grazing damage. The terminals of nearly all plants were injured and a large part of the foliage was removed. These injuries ceased in 1909, when stock was excluded, but the effect appears to be reflected in the growth for two or three years following.

APPLICATION UNDER OTHER CONDITIONS

After considering the possible influence of all factors, the conclusion that height growth is determined by moisture supply during the April-June period, as determined largely by the April and May precipitation, appears to be fully substantiated. Having established this conclusion, it is of interest to know whether it applies generally throughout the range of western yellow pine in this region. The same sequence of long and short internodes as shown in figure 1, particularly for the years 1915 to 1917, has been repeatedly observed in different localities on the Colorado Plateau. It has not been possible to correlate growth with precipitation over a long period of years in many localities, however, because of a lack of reliable meteorological records.

At Fort Valley the relation established for a level situation has been found to hold on north and south exposures. The relation is also strongly evident in planted trees below 10 years of age. Near Flagstaff, where meteorological records cover a long period of years, test measurements have been made on level sites and on east, west, and south exposures, and in every case the same relation was obtained as at Fort Valley. What is most remarkable is that almost the same graph is secured with a small number of trees as with a large number, when taken on the same site.

Instances have been observed where the relation here pointed out apparently does not hold. This is entirely in accord with what should be expected, because what is the critical factor on one site may not be at all critical on another site. In the upper altitudinal limits of the tree's range there appears to be no well-defined relation between height growth and precipitation. Here, on account of the relatively high precipitation and low temperature, moisture apparently gives way to temperature as the controlling factor. The same observation has been made in canyons where moisture is abundant.

Another factor which may assume a position of dominance is soil composition. At Fort Valley and over almost the entire San Francisco Mountain region the soil is a heavy adobe, which is penetrated with difficulty by plant roots, with the result that, as has been previously pointed out, the pine has a surprisingly shallow root system. On such soils trees are more sensitive to temporary drought than on porous soils, on which the roots penetrate deeper; in fact, it would not be surprising to find that on porous soils spring precipitation is subordinate to winter precipitation.

The age of the tree is another factor to be considered. Observations on mature and nearly mature trees of the size usually felled in lumbering operations have yielded no definite conclusions one way or the other, for the reason that they have passed the stage of vigorous height growth. In such trees one would be more apt to find a relation between moisture and diameter growth, as has indeed been found by Douglass. In a number of instances saplings 10 feet or more in height have been observed to show a different sequence of long and short internodes from that shown by smaller saplings on the same site. This condition is strikingly illustrated near the Fort Valley Experiment Station and at Prescott, Arizona. The probable explanation is that the older saplings have deeper roots, enabling them to draw upon the large moisture supply stored in the deeper soil strata during the winter, and thus rendering them less dependent upon spring precipitation.

SUMMARY

Western yellow pine in northern Arizona makes its height growth during the period of lowest precipitation in the year. During this period of high activity the trees are dependent almost entirely upon moisture stored in the soil during the preceding winter and spring. Normally the great bulk, and in some years all of this moisture, is stored during the winter months, December-March. When winter precipitation constitutes the sole supply, height growth in young saplings is apt to be small. If winter precipitation is supplemented by 2 inches or more in April and May (the rainfall in June is rarely sufficient to be of any consequence), a pronounced stimulus to height growth results. It may be stated, as a general rule, for the sites covered by this study, that 2 inches or more of precipitation between April 1 and May 31 is several times as effective as the same amount in excess of the normal precipitation between December 1 and March 31.

Factors reflecting atmospheric moisture conditions, including evaporation, wind movement, relative humidity, cloudiness, and length of rainless period, from April 1 to June 30, show a close, though not entirely consistent, relation to height growth.

Temperature on the sites studied appears to be important only in so far as it affects moisture conditions. Since the increase in temperature results in increased water consumption, height growth, if, as is usually the case, there is a shortage of moisture, varies inversely with temperature. Observations indicate that where moisture is abundant, height growth increases directly with temperature.

Complete records of soil moisture, if available, would probably show even a closer relation to height growth than does precipitation. The important fact pointed out by this study, however, is that it is the April and May precipitation which is most important in determining the amount of height growth, and presumably the moisture content of the soil during the period when height growth takes place. Since height growth is an excellent criterion of vigor, April and May precipitation appears to play a very important rôle in the reproduction of western yellow pine. Observations have in fact shown that the conditions which favor height growth of young saplings are also those which favor the survival of seedlings during the long, arid fore-summer, when mortality is usually very high. There is reason for believing that what has been discovered in regard to western yellow pine will apply to other tree species and to other forms of vegetation in this region, wherever moisture is a critical factor. That moisture conditions during the arid fore-summer exercise a profound influence upon vegetation is shown by the way in which various plants have adjusted their growth habits with respect to this period. A few perennials complete their seasonal growth and mature their fruit before June 1; the great majority, however, remain more or less dormant during the dry fore-summer and do not begin active growth until the advent of the summer rains in July. The same is true of annuals, many of which do not germinate their seed until the summr rainy period. Deep-rooted perennials, including forest trees, grow during the dry period of May and June, although the seeds as a rule germinate only during the warm, humid period of July and August.

There are sites within the range of western yellow pine in this region on which height growth apparently is independent of precipitation. An investigation of these sites would probably show that the moisture supply is normally abundant and that heat is the controlling factor. It will probably also be found that the control does not lie in mean annual air temperature. Possibly the relation will be found in the air temperature for a relatively short period of the year; more likely, however, it will not be found in air temperature at all, but in a direct measure of the heat absorbed by the leaves.

COMPARISON OF SEED TESTING IN SAND AND IN THE JACOBSEN GERMINATOR

By J. A. Larsen

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The prevailing method of testing seed at Forest Service Experiment Stations is by germination in sand. The advocates of the sand method maintain that tests so conducted come nearest to the conditions which naturally obtain in the nursery and field; that the amount of moisture, heat, and other physical factors affecting seed germination are more easily controlled; that this is the surest way to prevent damage by fungi, and that the tests in sand need less attention and care than tests conducted in any other media.

If the accuracy of the tests and the application of the results hinge so much upon testing and sowing in the same medium, we should expect to see soil taken from each individual seed bed for the testing of the seed intended for those beds. To do this it would be necessary to prepare seed beds in the fall in order to get a representative sample; but this is not practical, especially where the testing is carried on some distance from the nursery. Even if some investigators, actuated by an unshakable belief in the efficacy of this method, should insist on it for absolute results in a close study of comparative germination in the greenhouse and the nursery, their results would only be of local application and would have little value for field sowing.

The supporters of the sand method have also overlooked the fact that natural conditions do not occur in the sand tests. It would be impossible to duplicate the outside air temperature, soil moisture, air circulation, etc., in a greenhouse. The only thing which could be considered identical is the sand or soil, and that of all the factors is the least important in germination, and even this undergoes changes by leaching during the progress of the tests.

After several years of testing, the writer has found it very difficult to control the factors of heat, moisture, etc., for the sand tests so as to eliminate all variables. This is easily explained, since in order to have standard conditions the trays containing the sand must have the same size and shape, the sand must be taken from the same stratum from year to year, and the depth of covering, method of watering and sifting, temperature, and air circulation must all be identical.

If after extreme care the sand method of testing should be standardized, could the results obtained be corroborated or duplicated by future workers? The writer does not believe that this may be done, for there are too many variables involved. And here we have come to the main reason why so little progress has been made in testing of coniferous seed; there has been no standardized method or equipment.

Foreign seed investigators have long since abandoned the soil tests. One of the foremost Austrian investigators, Wilhelm Kinzel,[1] states in this connection that a critic who demands that comparative germination tests be carried on in soil appeals to such practitioners as have never had to do with the technique of comparative germination tests, and gives as the main reason the fact that a normal soil does not exist.

It was for the purpose of overcoming the disadvantages attending the sand tests and with a desire to perfect an apparatus which would give more uniform results, more rapid germination, and which could be more readily standardized that germination tests were begun at the Priest River Experiment Station with different media and containers. Among the methods tried were petri dishes, a water-jacket germinating chamber, an incubator, and a tank containing water over which the seed was suspended in folds of cotton flannel which touched the water. All these methods have been discarded. Since it would require too much space to give the results in detail, it is sufficient to state here that the main disadvantage of all was the impossibility of regulating heat and moisture conditions to suit individual species. Some of the seed germinated well for a while and then rotted, while some failed entirely to germinate. These objectionable conditions were largely overcome in experiments with a germinator modeled after the one in use at the Danish Seed Control Station in Copenhagen, known as the Jacobsen germinator.

The Jacobsen germinator is in itself a product of evolution in seed testing. It was perfected by Miss Ingeborg Jacobsen, of Copenhagen, after years of experience and visits to most of the European seed-testing establishments. The one used at the Priest River Experiment Station consists of a galvanized sheet-iron tank 13 by 22 by 5 inches, slightly wider at the top than at the bottom. The top is made of glass strips which rest upon an inside rim a half inch below the upper edge. The glass strips are placed close together and have notches ground

[1] Zeitschrift f. Forst u. Landw., Vol. 13, April and May, 1915.

equidistant on each side to allow the insertion of wicks leading to the water in the tank. The wick is attached to the center of a circular mat, eight centimeters in diameter, made from all-wool blanketing and resting on the glass plates. Over the woolen mat is placed an equal-sized mat of coarse cotton yarn, loosely crocheted, and over this is the filter paper on which the seed is laid. To allow air circulation, a hole, which connects with one ground in the glass plate, is cut through all three mats. The mats, filter paper, and seed are covered by an inverted glass funnel.

In this germinator the moisture conditions are regulated by the height of the water in the tank, the size of the wicks, and the amount of air admitted to the funnel. Heat may be furnished by alcohol or gas burners, steam or hot water pipes beneath the tank. (The latter method was used in this experiment in order to bring the temperature closer to that of the sand tests, which were heated in the same manner.)

For better circulation of the water and more uniform distribution of the heat in the germinator, a glass plate somewhat smaller than the inside of the tank was placed horizontally within the tank, about 1½ inches above the bottom.

This germinator was used by the writer during the winters of 1915-1916 and 1916-1917 and the results were contrasted with those obtained from the sand tests. Seeds of nine species of conifers native to Montana and northern Idaho were tested by both methods and the germinator was found to be the most satisfactory. Before considering the results, however, it is important to discuss the methods used and the care exercised, since these in a large measure influence the reliability of the conclusions.

The seed to be tested were separated from a larger lot by the use of a sampling machine. The smaller lot from which the final seed were counted was spread out one layer thick on a glass plate in such a manner that the seed touched each other. From this equal portions were removed for counting. Three samples, each containing the same number of seed, were weighed separately and the average weight determined. In case the weight of any one sample was more than 5 per cent above or below the average for the three, new samples were taken and the process repeated until the desired limit of error was reached. Three samples each of 200 seeds were used in the sand and three of 100 seed each in the germinator.

The sand was sifted into the trays through a one-twelfth inch mesh, after a given amount of coarser sand had been put in the bottom to give better drainage. The depth of the sowing surface, as well as its uniformity, was regulated by pressing a board of uniform thickness into the tray until another board nailed crosswise came to rest on the upper edges of the tray. An even depth of cover for the seed was secured by a straight-edge notched at the ends, so that the lower part fitted into the box, while the ends rested on the rim of the sand tray. The depth of cover was regulated by the distance the lower part extended below the rim of the tray. The difference between the thickness of the board used to form the sowing surface and the distance the straight-edge extends into the box is the depth of cover.

The seeds of *larix, picea, thuja, pseudotsuga,* and *pinus contorta* were covered one-half inch deep and the remaining species three-eighths inch. Watering was done with a hand sprinkler and in small quantities, so as to avoid any shifting of the sand cover. The water was applied only after the upper part of the sand began to show signs of drying.

Chemical agents were not used for sterilizing either the germinator or the sand tests, for it has been found that this is injurious in both. Sufficiently sterile sand is obtained at a depth of 6 feet below the ground surface and the water is fairly free from spores. In the germinator the seed was washed under cold, running water every three days to remove fungus spores, and at the same time the mats under the seeds were changed and sterilized by boiling and new sterile filter papers supplied.

Both the sand and the germinator tests were carried on during the winter months in the greenhouse, where heat was supplied by hot-water pipes. The temperature of the sand had a diurnal fluctuation between 60 and 90 degrees Fahrenheit, occasionally reaching 55 and 95 degrees, while that in the germinator ranged between 65 and 87 degrees Fahrenheit.

The results of these comparative tests are shown in the following tables:

TABLE 1.—*Average Germination per Cent*

Species.	Tests in Jacobsen germinator.	Tests in sand.	Days.
Larix occidentalis	60.3	28.5	26
Pseudotsuga taxifolia	49.0	39.2	26
Pinus ponderosa	36.7	15.5	30
Pinus monticola	22.0	18.5	32
Pinus strobus	12.0	6.5	35
Pinus contorta	60.7	58.3	21
Thuja plicata	69.1	54.7	24
Picea engelmanni	79.2	37.7	15
Tsuga heterophylla	49.7	40.5	24

TABLE 2.—*Per Cent per Day of Most Rapid Germination*

Species.	Tests in Jacobsen germinator.	Tests in sand.	Basis for comparison, days.
Larix occidentalis	9.1	3.1	2
Pseudotsuga taxifolia	7.9	3.7	2
Pinus ponderosa	3.9	3.5	2
Pinus monticola	2.0	1.2	2
Pinus strobus	2.0	0.8	2
Pinus contorta	18.0	14.0	3
Thuja plicata	15.8	7.0	3
Picea engelmanni	17.0	11.6	3
Tsuga heterophylla	5.3	6.5	3
Average	9.0	5.7	

TABLE 3.—*Days Required for Complete Germination*

Species.	Tests in Jacobsen germinator.	Tests in sand.
Larix occidentalis	25	40+
Pseudotsuga taxifolia	25	40+
Pinus ponderosa	30	60
Pinus monticola	(*a*)	200
Pinus strobus	(*a*)	200
Pinus contorta	20	20
Thuja plicata	15	25
Picea engelmanni	15	25
Tsuga heterophylla	25	25

(*a*) Not completed.

A comparison of the results by the two methods was made on the basis of (1) the total germination per cents attained when the tests in the germinator were practically complete; (2) the highest rates attained during the periods of the most rapid germination, and (3) the time germination began. (The terms "germinating force" and "germinating energy" are avoided because their meaning is not always clear.) Briefly stated, all of the nine species tested gave a much higher germination per cent by the Jacobsen method, and all except *tsuga* showed a greater maximum rate and earlier beginning. This difference is most strikingly brought out in the case of *larix, picea,* and *pinus ponderosa,* which more than doubled their counts in the germinator.

The results prove that the Jacobsen germinator is more suitable than sand for scientific work and for ordinary seed testing. More uniform results are secured and the method can readily be duplicated and standardized. The light, heat, and moisture conditions may more readily be controlled and measured than is possible with sand tests, and the condition of the seed may readily be observed at any time and seed may be removed at will for the purpose of physiological study. This method possesses great economic advantages which are worthy of consideration in ordinary seed testing. The tests may be completed in much less time; an expensive greenhouse and high costs for fuel are avoided, since a germinator large enough for from ten to fifteen duplicate tests can be made for about $25, and it can be used in any laboratory, office, or kitchen and be heated by means of gas, electricity, oil, or alcohol.

This germinator is most suited for use with the more rapidly germinating species, and for these the differences in rate of germination and the time required is most pronounced. It may, however, be used to good advantage with the slower species, as *Pinus strobus, Pinus monticola,* and the species of *Abies*, provided a satisfactory pre-germination treatment has been discovered. In the above tests *Pinus monticola* seed was treated by mixing with moist, bark-free sawdust for six weeks.

It is a matter of great importance in seed testing to uncover the reason for the more rapid germination by the Jacobsen method. It is not due to heat alone, because the temperature rose higher in sand and maintained a similar fluctuation and average. The moisture conditions surrounding the seed are much more uniform in the germinator, but only a small part of each seed touches the wet filter paper, leaving the rest of the seed exposed to a moist-air medium, while the seed in the sand is in contact with the sand particles, and most of the moisture made available for the seed is in the form of capillary water. The results of these tests, as well as germination in sand of the same species of seed under different conditions of air moisture, during which better germination took place under increased moisture, lead to the supposition that germination is hastened more by water vapor than by moisture in a liquid state. It is probable that the greater heat energy in moist air as compared with dry air causes the more rapid germination, for it is an established scientific fact that under a given pressure of 760 millimeters and a temperature of 50 degrees Fahrenheit one kilogram of saturated air, then containing 7.5 grams in the form of vapor, possesses as much heat energy as dry air at 84 degrees Fahrenheit.[2] This brings us face to face with a new factor which may prove of great importance in seed studies and which offers an interesting field for future investigations.

[2] Der Warmeaustauch in festen Erdboden in Gewässern und in der Atmosphäre. Julius Springer, Berlin, 1904.

FUNGI AS CONTRIBUTORY CAUSES OF WINDFALL IN THE NORTHWEST

By Ernest E. Hubert

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Each year a large amount of direct damage and loss of valuable timber is produced on the forested areas of the Northwest through the violent action of winds. Great areas of immature and mature merchantable trees are blown over in regions as yet inaccessible to profitable logging. The trees in such windfall areas remain on the ground and decay, or are left to form menacing tangles of inflammable material which invite lightning and other factors to the kindling of a destructive forest fire. Even in regions accessible to profitable logging, windfall areas, especially the smaller ones, must often be logged at a loss in order to save the timber. The cost of operation on such an area often results in the forced harvesting or premature cutting of the entire forest unit. This is sometimes done before the unit has reached its intended cutting age, and so deprives the owner of the added value which the stand would have returned if it had been left to complete its growth. Other factors concerned in the logging of comparatively small and ioslated windfall areas enter into the economic consideration and too often turn such an operation into a loss. These factors, such as distances from the market, the mills, and ready transportation, are mainly based on the location of the windfall area within the forest. The breakage of the merchantable timber, the increased cost of logging due to the tangled position of windfalls, and the presence of considerable unmerchantable down timber, all add considerably to the risk of logging such areas. Heart-rotted trees are very easily broken by the force of high winds, and considerable damage is caused in this manner. The breakage of tops of healthy trees is brought about by the falling of trees thrown by the wind, but more often trees broken in this manner are also found to be rotted. Aside from the damage due to fire, the loss through forced logging and the attendant loss through breakage of merchantable windfalls, breakage and wounding of standing trees, the windfall area, if unaltered by fire or logging operations, quickly forms a breeding place for forest-tree insects, and later becomes an area of fungous activity.

Fungi are the natural rot-producing agents in our forests, and attack all species of trees, killing some outright, while in the majority of cases decay renders the heartwood unmerchantable. Certain of these fungi have been found operating almost exclusively in the roots and in the butt portions of the tree. This has led to the question of the relation fungi bear to the windfall problem and the extent to which fungi are directly responsible for windthrow. It is a known fact that injuries to standing trees, no matter how produced, form ready entrances for rot-producing fungi. Dead branches of standing, living trees are often broken off by wind. The resulting branch-stubs offer a ready means of infection. Falling trees often injure their neighbors, either by breaking off branches or damaging the bark. These injuries favor the entrance of fungi into the heartwood, and this is followed by decay and subsequent loss. The relation of this phase of the windfall problem to fungi is not very difficult to trace, but the part fungi play in causing windfall is one which necessitates a more detailed and careful study. The aim of this paper is to consider all the factors concerned in the overthrow of trees by wind and to demonstrate the extent to which fungi are responsible for windfall, as well as to consider other apparent relations between fungi and windfall timber.

CAUSES OF WINDFALL

The primary or direct cause of windthrow is the force exerted by air currents upon the crown surface exposed in the stand, the trunks supplying the leverage. This force generally expresses itself in the form of high-velocity winds and storms.[1] Tornadoes, hurricanes, whirlwinds, and other forms of air currents are found responsible in some regions for the overthrow of great areas of timber. In some cases windfall is produced by sudden and powerful draughts accompanying large forest fires. These air currents sweep through narrow canyons and over ridges, and by their force mow down large areas of partly burned trees as well as portions of the stand untouched by the fire. In the great fires of 1910, which swept away millions of acres of valuable timber, the windfall due to the draught of the conflagration on the St. Joe and Cabinet National Forests covered approximately 28,000 acres. Ground fires of smaller importance often sweep through a forest, severely burning the trees at the base and exposing and burning

[1] Fürst, H.: The Protection of Woodlands. 1893. Trans. by John Nisbet. Classifies air currents as follows: Winds, velocity of 66 feet per second; storms, 66 to 116 feet per second; hurricanes, above 116 feet per second.

the roots. This greatly weakens the tree, and the first wind of sufficient force causes a windthrow of the weakest ones.

Other but less frequent causes of windfall and windbreakage are found in unusually heavy snowfalls, heavy sleet and ice cappings, and in extreme low temperatures accompanied by wind. Occasionally heavy snows or ice cappings are to be classed as primary causes, since they cause overthrow, bending and breaking of trees without the aid of the wind. The increased weight upon a tree of a large mass of snow or ice or sleet causes the tops of the weaker trees to bend over and sometimes to break. Many are broken off near the tops or lower down on the trunk, while others are bent over low on the ground or overthrown. In the winter of 1915 a very heavy snowfall, accompanied by sleet, occurred in all the forest regions of Montana and northern Idaho. A large amount of damage was done to young trees in unprotected situations, to mature tall trees in dense stands, and to weak trees by breakage of trunk and branches and by bending to such an extent that recovery to a normal position was impossible. During the same winter, on the Missoula National Forest near Bonner, Montana, a severe early cold spell, accompanied by high winds, caused a phenomenal loss of the outermost tips of the branches. After the storm the ground was carpeted with green branch tips from 2 to 10 inches in length of various conifers. The extreme low temperature made the branch tips very brittle, and the high wind succeeded in breaking them off in large quantities. This is a considerable loss, viewed from the angle of seed and needle production, since a great number of the pollen and seed cones as well as leaf buds were removed with the twigs. The Douglas fir (*Pseudotsuga taxifolia* (Lam.) Britt.) suffered the greatest loss. Mason[12a] gives an account of snow damage to lodgepole pine (*Pinus contorta* Loud.), which usually occurs on young trees 4 inches or less in diameter, bending them to the ground or breaking them off at a height of from 10 to 20 feet.

The secondary or indirect causes which are concerned with windfall of trees are more numerous and complex, ranging from the activities of forest management to the effect produced by root- and butt-rotting fungi. So many of these factors are found combined as secondary causes that it is difficult to single out any one cause as predominant in its effect. Usually two or more causes will be found of nearly equal importance in relation to the wind damage to particular trees. Briefly, the various factors will be taken up, commencing with such causes produced by the activities of forest management.

Whenever heavy thinnings are made in dense stands, or when clear cuttings are made on the edges of dense stands, they are very likely to result in heavy windfalls, unless other factors enter to protect the exposed trees. The removal of trees from a dense stand causes gaps to occur in the crown, which present to the force of the wind unprotected crown surfaces. In a dense stand the trees are usually crowded and tall, producing the crowns high up on the stem. When such a stand is left undisturbed, under ordinary circumstances the dense association of the trees affords mutual protection from wind. If an opening is made by thinnings or clear cuttings certain of the trees become exposed, their resistance weakened, and the first high wind is very liable to overthrow them, often resulting in a large windfall area. Individual seed trees selected from dense stands, when not properly protected from the wind, are more liable to windthrow than groups of such trees selected for seeding purposes. This is evident from the fact that groups of trees supply mutual protection and are therefore more windfirm.

Fürst,[7] Hess,[9] Nisbet,[16] Fisher,[5] and other European writers have laid stress upon the windfall loss due to heavy thinnings and to clear cuttings or "gap-fellings," and recommend care in the selection of trees in selection cuttings and strip cutting in dense stands instead of "gap-fellings." In the latter operation proper regard should be had for the direction of the prevailing winds. Isolated trees having shallow root systems and in exposed situations are recommended to be removed.

Among the more recent writers of this country Fernow,[4] Frothingham,[6] Woolsey,[24] Sterrett,[20] and Mason[12] treat upon the windfall danger due to various cutting operations. The consensus of opinion is against drastic thinnings, and in most cases it is recommended not to leave individual seed trees. In the case of lodgepole pine on the Deerlodge National Forest it was found[12b] that selection cuttings, properly handled, worked much better than the seed block system, especially in exposed, dense stands, where windfall trees amounted to as high as 90 per cent of the trees left after cutting. Here the tall, slender, top-heavy growth habit of this tree makes it particularly susceptible to windthrow. Woolsey,[24] treating of western yellow pine (*Pinus ponderosa* Laws), and Sterrett,[20] on the scrub pine (*Pinus virginiana* Mill.), state that these trees, when normally growing in dense stands and suddenly exposed to wind, are not found to be windfirm, and considerable damage results. In the case of yellow pine, seed trees, unless left in groups or otherwise protected, are very liable to be thrown by the wind. Mattoon[14] reports considerable damage to shortleaf pine (*Pinus echinata* Mill.) from wind action and from ice storms in the tornado region of the Middle Western States.

The site upon which a stand of timber grows has a marked effect upon the chances of windfall. Exposure to air currents by means of high, exposed ridges and by narrow, draughty canyons presents, in amount of wind damage, a marked contrast to such sites upon which the stand is protected from the direct action of the wind. High, exposed sites along ridges either disclose considerable windfall and wind breakage or exhibit a stand of dwarfed and eccentrically shaped trees, due to the direct action of the wind. Hess[9] shows that a tree growing upon a slope is more easily thrown down hill than up, due to these four factors: (1) Trees are more heavily branched on lower side; (2) root development offers greater resistance to wind blowing up hill; (3) ascending wind encounters greater resistance; (4) tree is more easily overbalanced and thrown in a downward than in an upward direction.

One of the principal factors concerned in the windfirmness of individual trees and stands is the character of the soil in which they are growing. Wind action on trees growing in loose, wet soils causes windfall, while in firm, rocky soils the windfall danger is greatly lessened and breakage is the rule. This is evident when windfall areas are studied. The loose moist soils offer little resistance to the pulling out of the root crowns as the wind force tilts the tree and consequently overthrow results. The presence of impermeable layers in the subsoil often prevents the roots from penetrating to any considerable depth. This condition subjects the tree to windfall. Hess[9] states that trees growing on granitic basalt, gneiss, and porphyritic soils are less subject to windfall. Smith and Weitknecht[18] find as a result of observation made on a yellow-pine area that windfalls are as numerous on medium and deep soils as on shallow soils. Hodson and Foster[10] find that Engelmann spruce (*Picea engelmanni* Engelm.) growing on thin soils in exposed places is very subject to windthrow. In some cases the roots were found not more than two feet below the surface.

Excessive rainfall generally precedes a windfall, and it is found that heavy rains before or during a storm greatly increase the damage.

The species of trees seem to offer varying degrees of resistance to windfall, and this is no doubt largely due to the root system. Shallow-rooted trees have been found predisposed to windthrow more so than the deep-rooted species, and the wind action upon shallow-rooted species invariably causes windfall, while in deep-rooted species breakage is more common. An interesting point in connection with the root system of spruce has been reported by Matthes.[13] He finds that spruce trees are rendered more windfirm on areas where species of lupine and alder are growing in close proximity to them. It is stated that the spruce on such areas possess greatly extended and penetrating root systems, and these are due to the presence of nitrogen-producing bacteria in the root nodules of lupine and alder. The spruce roots have been found to grow toward these nitrogen-supplying nodules, thus stimulating the roots to further penetration into the soil.

Aside from the roots the shape and height of the tree bear important relations to the action of the wind. Dense stands produce tall, top-heavy trees, whose size and position of crown place them in a favorable position for windfall. This has been found true of several species of trees, but more particularly so for the lodgepole pine.[12] Pure stands and the age of stands also are factors in wind resistance. Pure stands of shallow-rooted trees are less windfirm than if occurring in a mixture with other more deep-rooted species. Pure stands, with the exception of a few species, are also inclined to become dense.

The danger from windfall increases directly in proportion to the age of the stand. With age come larger and taller trees, larger and denser crowns, and greater mass. These all contribute to the greater leverage and windfall damage is thereby increased. Hess,[9] Nisbet,[16], Sterrett,[20] Baker,[1] Smith and Weitknecht,[18] and Mason[12] state that the increasing age of the stand also increases the danger from windfall. The observations of Smith and Weitknecht[18] show that the largest, tallest, and heaviest-crowned trees were the most subject to windfall. Baker[1] came to a similar conclusion in his observations upon a windfall area of 3,480 acres in the Olympia National Forest in Oregon.

The factor of increasing age brings up the point which is the paramount consideration in this paper. Previous works[15, 25] have shown that with increasing age in fungous-infected trees comes a proportionate increase in the volume of rot. This holds true for a tree species after it has entered the infection age which determines the earliest age at which the fungus enters. Since the roots of trees are particularly designed as braces and anchors for the resistance of windthrow, and since root and butt rots are common in most species of trees, it is readily seen that the action of fungi must bear some important relation to the relative wind resistance of infected and uninfected trees. Increased decay, whether of the trunk or of the roots, represents a proportionate decrease in the strength of those parts and a reduced resistance to the force of the wind. Therefore, most of the other factors remaining constant, it is believed that a tree having sound roots resists windfall and a tree having a sound trunk resists windbreak, and that a tree having infected roots and trunk will be more susceptible to the action of the wind.

Graves,[8] Fürst,[7] Nisbet,[16] Reuss,[17] Bernhardt,[3] Fisher,[5] Matthes,[13] Weigle and Frothingham,[21] and Weir[22] are some of the investigators in forestry subjects who record the direct relation between defective roots caused by fungi and resultant windfall. Reuss finds a large amount of root rot present on a 48-year-old spruce plantation which had suffered considerable snow-throw and windfall. This rot he ascribed as a cause for the windfall, tracing the entrance of the fungus to a too-deep planting of the roots. Matthes[13] states that in trees with shallow roots the wind action causes the breakage of many of these roots, even though the tree itself is not thrown. To this wounding of the roots he attributes the majority of the root rot. The attack of the roots by insects is also given as a cause for fungous entry. In respect to root injury as a means of fungous infections, it is well to mention here the part played by fire scars. In a report on the forest reserves, published in 1898, Graves[8] states that fire scars at the base of trees allow decay to creep in, thus weakening the trees, causing windfall and also windbreak at the base. Fire scars are among the most important factors in western white pine (*Pinus monticola* Dougl.) to which fungous entrance is traced. Most of these scars occur as "cat faces" at the base of trees, the fire often exposing and injuring the roots, and in this manner root and butt rots enter the tree.

Weir[22] gives an account of observations on windfall trees of Douglas fir, western yellow pine, and western larch (*Larix occidentalis* Nutt.) found upon an area in the Whitman National Forest of Oregon. Root rot was found directly responsible for the weakening of the brace roots and subsequent windthrow. The honey mushroom, *Armillaria mellea* (Vahl.) Quél., was found to be one of the root fungi attacking the trees.

The principal fungi concerned in the problem of the relation of fungi to windfall are those which attack the roots either as heart or sap rots. Frequently a typical heart rot of the trunk advances deep into the butt of the tree and invades the heartwood of the roots. The butt rots normally extend to a greater or lesser extent into the roots, advancing a considerable distance into such roots as are large and contain much heartwood. Of the fungi considered above, *Fomes annosus* Fr. and *Armillaria mellea* are the most important sap-rotting species. *Polyporus schweinitzii* Fr., *Trametes pini* (Brot.) Fr., *Echinodontium tinc-*

torium E. & E., and *Sparassis radicata* W. are the heart-rotting species most commonly found in the roots of windfalls.

The most important root-rotting fungus of the northwest region is *Polyporus schweinitzii,* which is found to attack all the principal pines, the larches, Douglas fir, western red cedar (*Thuja plicata* Don.), spruce, western hemlock (*Tsuga heterophylla* (Raf.) Sarg.), and grand fir (*Abies grandis* Lindl.). It is generally found acting as a butt rot in timber trees and produces a dry, reddish brown rot which breaks up into more or less cubical portions upon exposure to drying. Although a typical butt rot, it is found to advance into and beyond the second log in many of the older trees. The fruiting bodies develop at the base of the tree, springing through the soil from underground attachments to injured roots, and are occasionally found developing as shelf conks from injuries occurring at the base of the host. The fungus when growing upon the soil is somewhat circular in outline, reddish to dark rusty brown in color, having a light yellow margin when young and a short thick central stalk. The porous, under surface is greenish brown when fresh, turning to a dark brown shade when bruised.

Trametes pini and *Echinodontium tinctorium,* both typical heart-rot fungi operating in the main trunk of the host, are occasionally found penetrating a considerable distance into the heartwood of the larger roots. *Trametes pini* universally attacks all the coniferous trees, producing a characteristic honeycomb rot having white pits scattered throughout the rotted areas. The sporophores are shelf-shaped to hoof-shaped, hard, rough, and of a dark grayish black color, with the under surface of fine pores of a brownish yellow color when fresh. In host species having little resin this fungus often attacks the sapwood.

Echinodontium tinctorium, the Indian paint fungus, occurs almost exclusively upon species of Abies, producing a very destructive heart rot of a reddish brown color. The rot is very characteristic in having patches of vivid rusty red scattered through the stringy brown rotten wood. The fruiting bodies are very unique in that the under surface is composed when mature of long white spines. The upper surface is rough, zonated, often cracked, and of a black to gray black color. The fruiting body is generally hoof-shaped.

Fomes annosus, a typical root-attacking fungus, is chiefly found injuring the roots of Engelmann spruce, occasionally western white pine, and to a lesser extent other conifers. It is both a sap and heart rotting fungus and when found infecting a stand does considerable damage. It plays an important part in the weakening of the roots of the host attacked. The rot is characterized by white pits having black centers, although this latter character is not always present. The fruiting body is principally confined to the roots, appearing as resupinate bodies having a white under surface of fine pores and a projecting edge of a light gray brown color. Occasionally distinct shelf-shaped conks are found. A fine mycelium occurring under the bark scales of the roots indicates the presence of the fungus.

Sparassis radicata and *Armillaria mellea* are also found to attack the roots of conifers in the Northwest, causing decay and subsequent weakening of those parts. *S. radicata,* a new species recently described by Weir,[26] is found attacking the roots of western white pine and Douglas fir. *Armillaria mellea* does the greatest injury when attacking very young growth, but is also found occasionally attacking the roots of mature western white pine, western yellow pine, western larch, Douglas fir, western hemlock, and grand fir.

AMOUNT OF DAMAGE CAUSED BY WINDFALL AND WINDBREAKAGE

The amount of damage caused directly and indirectly by windfall and windbreakage is to be reckoned in millions of feet board measure annually. This loss is important, in view of the ever-decreasing timber supply and increasing inaccessibility of the remaining stock. Very little data covering the entire forested areas of the United States are at hand giving specific figures upon the amount of loss in board feet due to the destructive action of wind. Often the loss is not direct, but comes indirectly through the forced logging of windfall areas or as a consequence of forest fires. Figures upon the latter losses are not available, but, if so, would undoubtedly throw some valuable light upon this phase of the problem.

Of the purely windfall and windbreakage losses the following are good illustrative examples as occurring upon national and privately owned forests of the Northwest:

Smith and Weitknecht[18] state that "upon an area cut over by the selection system 20 per cent of the thriftiest, soundest, and youngest trees of the original stand were left." After two storms, one in 1913 and the other in 1914, "969,876 board feet, or 17.5 per cent, by volume of the reserved yellow pines over 12 inches d. b. h. had been windthrown on this one sale area—a loss in two years which, if continued, would mean in a few years more the total loss of the reserved trees." This, it is stated, does not include loss by wind of larch, Douglas fir, lodgepole, and white fir, which are even more susceptible to windfall than yellow pine. A total of 3,621 windfalls of all species were recorded on an area of 4,000 acres of cut-over land 20 per cent stocked.

More accurate data relative to the loss in feet board measure due to windfall alone for the areas covered by Forest Service Districts 1, 2, and 6 are given in Table 1. These reports possibly do not cover every individual windfall area within the indicated districts, but at least include all the larger and more important as well as the greater number of smaller areas. From the totals secured from these reports, it is seen that a loss of over 387,322,000 feet board measure of all species, valued at approximately $260,800, has occurred over this area—the majority of this during the past two years (1915-1916). A certain portion of this loss is preventable, and all means possible should be applied in reducing the annual loss from this source.

FIELD DATA ON WINDFALL AREAS

In the fall of 1916 questions on windfall damage were prepared and sent out to the forest officers of the national forests included in Districts 1, 2, and 6 of the Forest Service; also to various logging companies of the Northwest. The information secured upon the return of these sheets was found to be extremely interesting, and the data were summarized in a table (Table 1). In all, 98 reports were received on as many different windfall areas, scattered throughout the States of Washington, Oregon, Idaho, Montana, Wyoming, Colorado, Minnesota, and Michigan. Of this number, 90 were used in the included tables, those excluded being incomplete. These areas aggregate a total loss of 387,322,000 feet, board measure, valued at approximately $250,800. Of this total, 3 per cent by volume, or 12,275,000 feet, board measure, valued at $23,642, was found to be directly traceable to fungous attack as a secondary cause of windfall. The greater portion of this loss is traceable to the action of root fungi and the remaining lesser portion to butt and trunk rotting fungi, which latter are largely responsible for the direct breakage of the trunks. The striking point brought out by a table not included in the text is the almost invariable association of fungi as secondary causes in windfall wherever stands of old-age trees are overthrown. This is to be expected, especially in trees subject to root fungi and growing in damp, shaded, and poorly drained sites.

Of the 90 windfall areas reported upon (Table 2), 16, or 18 per cent, were found which had fungi as the principal secondary cause, and 9, or 10 per cent, in which fungi were responsible for only a smaller portion of the windfall, leaving 62, or 73 per cent, of the areas in which other causes, such as exposure, tree heights, crown sizes, soil condi-

TABLE 1.—*Summary of Windfall Data*

(From Forest Service reports received from Districts 1, 2, and 6.)

District	Range in areas (Acres)	Average direction of windfall.	Average per cent of down trees to total trees on area.	Complete windthrow areas (95-100 per cent of trees are down). No.	Complete windthrow areas: %	Average condition of soil.	Average condition of roots.	Average age. (Years)	Average height of trees. (Feet.)	Most common secondary cause.	Damage: Board measure. (M. feet)	Damage: Valuation. (Dollars.)	Total No. windfall areas
1	2 to 25,000	SW	42	4	11	Loose and moist	Pulled out entire and sound	159	96	Soil conditions	89,762	42,771	35
2	1 to 2,000	SW	66	9	31	Loose and moist	Pulled out entire and sound	162	70	Cutting operations	25,995	96,661	29
6	2 to 2,280	NE	53	10	35	Loose and moist	Pulled out entire and sound	258	127	Root fungi	271,565	131,328	26
Total				23	26						387,322	260,745	90

tions, cutting operations, etc., were recorded as secondary causes of windfall. Of the number of areas having fungi as secondary causes of windfall, 2 are reported without having given the loss in feet board measure or the valuation. Five of the areas having other secondary causes than fungi are also similarly reported.

TABLE 2.—*Table Showing the Grouping of the Various Windfall Areas of Table 1 under the Principal Secondary Causes of Windfall*

National Forest district.	Cutting operations.	Soil conditions.	Fungi.	Exposure.	Root system.	Heavy snows.	Tall trees.	1910 fire.	Tornadoes, hurricanes, etc.	Total number of areas.
No. 1......	5	10	5	4	3	3	0	2	3	35
No. 2......	10	5	4	5	2	2	1	0	0	29
No. 6......	6	6	7	3	2	1	1	0	0	26
Total...	21	21	16	12	7	6	2	2	3	90

Table 2 gives the relative importance of the various secondary causes of windfall as found in the areas reported in Table 1. It is seen that windfall due to cutting operations and to soil conditions rank first, followed by fungi, exposure, and so on down. It is significant that fungous activity is shown to be a close second as a secondary cause of windfall, and that cutting operations and soil conditions are first. In District 1, 30 per cent of the windfall areas were reported with soil conditions as secondary cause, 14 per cent equally to cutting operations and fungi, and 10 per cent to exposure. In District 2, 31 per cent to cutting operations, 17 per cent equally to soil conditions and to exposure, and 14 per cent traced to fungi. In District 6, 27 per cent were reported with fungi as secondary causes, 23 per cent equally to cutting operations and to soil conditions, and 11.5 per cent to exposure.

Cutting operations resulting in the removal of a portion of the stand and suddenly exposing a previously protected portion are evident secondary causes in the overthrow of trees. It is to be expected that too severe marking, or marking without considering the wind-resisting powers of the remaining stand, will invariably result in windthrow on such sites exposed to severe wind action. On the other hand, little attention has been paid to the part played by fungi in rotting, and thus weakening the roots and trunks of trees to such an extent as to cause wind breakage. For the reason that fungi have been found to cause a large portion of the windfall damage, it is important that the subject of seed trees be taken up in this connection. Forest Examiner Rockwell, of the Cœur d'Alene National Forest of Idaho, has collected data upon areas aggregating 21 acres, which show that a large portion of the windfall seed trees of western white pine on cut-over areas are overthrown by the wind on account of the weakening of the roots due to fungous activity. In many cases, no doubt, the exposure has its effect upon the seed trees suddenly exposed to the wind, but this is at the same time augmented by the weakening and subsequent breakage of the root system through the rotting of the roots. The figures given for four acres representing different sites were averaged and the following figures secured: The per cent of down trees to total trees reserved, by species, is white pine 11.1 and Douglas fir 15.9. The per cent of down trees to total trees reserved, whose secondary cause of windfall is determined due to fungi, by species, is white pine 5.3 and Douglas fir 3.5. Comparing these percentages, it is seen that in white pine fungi are responsible for 47 per cent of the windfalls and in Douglas fir 22 per cent. These figures show that in white pine fungi are responsible for nearly 50 per cent of the windfalls in such areas where seed trees are reserved, and that fungi are important, though not to as great an extent, in Douglas fir.

It is, therefore, evident that all seed trees left on a cut-over area should, for the purposes of forest sanitation as well as for the wind-resisting qualities, be trees which are absolutely free from fungous infection. This not only applies to seed trees, but likewise to all trees left upon an area after cutting, whether seed trees or trees left as a result of selection cutting. The retention of sound trees in all cases on a cut-over area would insure the maximum of wind resistance, providing other conditions contributing to the hazard of windfall are considered. If sound trees only are allowed to remain, forest sanitation will be benefited and there will be much less danger of windthrow.

A sample acre on a windfall area occupying a portion of the Honeysuckle sale area, on the Cœur d'Alene National Forest of Idaho, throws some light upon the part played by root and butt rotting fungi attacking western white pine. On this sample area 78 per cent, or 101 out of 129 trees of various species, were windthrown during the spring of 1913. The majority, approximately 85 per cent, of the windfall trees were western white pine. The remaining 15 per cent were Engelmann spruce, grand fir, and western hemlock. The white pines were of an old-age class (141-160 years) and had a full development of the rot of *Polyporus schweinitzii* occupying the butt section and extending downward into the larger roots. Of the windfall white pines there were 60 trees, or 59 per cent of the total trees thrown, found infected with *P. schweinitzii.* Three (two white pines and one spruce), or 3 per cent of the total trees thrown, had their roots rotted by *Fomes annosus.* In the majority of cases where the main roots were rotted they were found broken off short near the stump. Fungous attack and a very moist and loose soil are the two secondary causes determined as responsible for this windfall, the fungous action ranking first. From the foregoing data it appears that the windfall damage attributable to the species of fungi attacking the trees is in proportion to the prevalence of the various species of fungi in the stand, and also depends upon the stage of development of the rot at the time of the windstorm.

An area of mixed windfalls on the Humbird Lumber Company's land, near Priest River, Idaho, covering approximately four acres, was examined in the fall of 1916, just after the area had been cut and before the logs had been removed. Approximately 158 trees were overthrown by a high wind on July 12, 1916. The windfall occurred upon a strip of bottom land bordering the Priest River, and was timbered with an old-age class of the western white pine—western hemlock type. The soil was found to be a soft, sandy loam, very moist and very poorly drained. The stand was densely stocked. Sixteen white pines were carefully examined and field notes taken in conformity with the outline for windfall data (Table 1). Of the 16 trees, 13 were of the 160-200-year age class and 3 of the 201 age class. All the trees were found to exceed 125 feet in height and the tallest one measured 173 feet. Every tree was found heart-rotted, either with *Trametes pini* or *Polyporus schweinitzii.* In eight cases this heart rot extended into the roots of the infected trees 4 to 8 feet. Critical examination of the roots showed that 14 of the trees had rotted roots, and the main roots of 13 of these were broken off from 2 to 4½ feet from the stump. Of the rot in the roots, six of the trees bore root rot traceable to *Fomes annosus,* six to *Trametes pini,* and two to *Polyporus schweinitzii.* Two were found to be sound, and were pulled out of the ground instead of being broken off short near the stump. All of the trees fell with their tips pointing northeast, which was found to be the general path of the wind causing the overthrow. All were prone upon the ground excepting one, which was but partially overthrown. This tree was found to have sound roots, and its overthrow can be ascribed to the impact received from a neighboring windfall and to the softness of the soil.

Not all of the trees upon this area were overthrown, although as greatly exposed to the wind as those that fell. Examination of the stumps and roots of the trees left standing after the windstorn showed less root and butt rot present than in the overthrown trees. Several grand firs, heavily infected with *Echinodontium tinctorium,* were broken off several feet from the ground as a result of the storm.

A conclusion drawn from the immediate Humbird data favors the following factors as being important as secondary causes: (1) Fungi, (2) soft, undrained soil, and (3) old-age class. Of these secondary causes, the action of fungi in rotting and weakening the roots stands out as the most important of the causes named. It also indicates that the trees having less root, butt, and heart rot were able to resist overthrow and breakage.

DISCUSSION

The review of the literature on the subject of windfall and wind damage in general has disclosed the fact that fungi operating in the roots and butts of timber trees are to be seriously considered as secondary causes in windfall damage, and that fungi operating in the trunks of trees are the very serious causes of breakage in standing timber when high winds become prevalent. It has also been made evident that the yearly damage to our forests by the overthrow of stands of timber and individual trees through the force of the wind represents a loss which cannot well be overlooked in view of the present need for conservation. The data presented give an insight into the prevalence and distribution of the damage due to windfall, as well as indicate the various secondary causes responsible for the overthrow and their relative importance. They also furnish an index to the important part which fungi play in acting as secondary causes to windfall and windbreak damage, and furnish arguments in favor of enforcing sanitation clauses on all timber-sale areas and the reserving of sound trees for seed trees.

It is well to take up here the data showing the direct responsibility of fungi in causing windfall. It has been shown that the amount of windfall and wind breakage traceable to fungous activity is large enough to be of economic importance in the administration of the National Forests. This fact has been emphasized in connection with trees left upon an area for future crops following cutting operations and with trees left as seed trees. The methods by which the determination of the secondary causes are made in the field should be presented. Since the study emphasizes fungous activity as a secondary cause of windfall, special attention was given the diagnostic methods for this determination. The first factor of importance is the rotting of the roots. Either heart rot or sap rot found weakening the resistance of the roots to the overthrow force of the wind is considered a good indication of the cause of windfall. In connection with this, it was found that almost invariably the root-rotted trees which were windthrown showed the main infected roots to be broken off rather short near the butt of the tree, and not pulled out entire with masses of earth clinging to them, as in the case of sound-rooted windfalls. The proof of the determination that fungi cause windfall is not always easily determined in fungous infected stands, since many sound trees within such an area are overthrown by the weight of falling trees or by the loosening of the soil and root system through the uprooting of neighboring trees. The windfall area studied on the Honeysuckle sale area previously mentioned presents conditions which are capable of being used in comparing the relative results of wind action upon two similar portions of a stand, one infected with root and butt rot, the other having but a slight amount of either. The portion of the stand suffering windfall is located in a slight depression of the valley floor bordering the Little North Fork River. This area was found to be poorly drained, and as a consequence root fungi were well established in the trees. An examination of the area disclosed a majority of the windfall trees with rotted and broken roots. The area used as a contrast fall area and is a portion of the same stand. The site is similar—along the bottom land bordering the Little North Fork River—but is favored with a slight slope toward the river, thus insuring better drainage. The trees on this site were of a slightly younger age class, and upon examination, following the cutting operations, it was found that butt rot existed in a lesser degree and very little root rot was present. These trees all withstood the storm which overthrew the stand upon the other less favorable area. A conclusion is reached that the better drained site, having very little root and butt rot, composed of a slightly younger and therefore presumably sounder age class, and occupying a similar position on the valley floor in respect to the path of the wind, was, by reason of its sounder condition, better able to withstand the overthrow force of the wind. The exposure, tree heights, crown size, etc., were practically the same for the two areas, so that no other secondary cause of windfall than fungi could be attributed. The data previously presented from the Priest River region also favor this conclusion.

The preceding paragraphs bring out the facts that the power of resistance of unsound trees to heavy wind storms is very materially impaired, and by inference that sound trees possess a very much higher resistance. These facts form a basis for general recommendations regarding the sanitation of the forest as well as for windfall prevention.

RECOMMENDATIONS

Seed trees selected and marked to be left after the area is logged should be sound and thrifty, not too tall nor with large, top-heavy crowns. They should, if possible, be grouped for mutual protection against the wind and should not be selected on exposed sites where the wind action is strongest. For best results the soil should be comparatively firm and well drained, so as to safeguard against the loosening of the soil by the melting of snows, heavy rains, and poor drainage. Shallow soils with "hard-pan" layer just beneath should be avoided. Shallow-rooted tree species especially susceptible to windthrow should be reserved on wind-protected sites only.

Similar recommendations are offered for application in marking trees to be left upon an area following selection cuttings or thinnings.

SUMMARY

The conclusions derived from this study are as follows: Windfalls are a financial loss in most cases, and where not harvested act as a fire menace to the remaining stand or as developing centers for forest-tree insects and forest-tree diseases.

Windfall is prevalent in all types, sites, and localities which are most favorable to windthrow. From the data secured and from observations in the field, it appears that the lodgepole-pine type is the most susceptible to windthrow. Such sites as exposed ridges, gaps, and saddles in ridges and sites unprotected from the full sweep of the wind are most commonly given to windfall. From the viewpoint of locality, the data recorded indicate the Pacific-slope region of the Northwest to be the most severely damaged by the windfall, although the Rocky Mountain windfall region forms a close second in respect to area covered.

The force of the wind is classified as the primary cause of windfall, and all other causes, such as cutting operations, fungi, soil, fire, snow, height of trees, size of crowns, exposure, etc., are classed as secondary causes. A certain amount of overthrow and breakage is traceable to heavy snow and ice cappings as primary causes.

Of the various secondary causes, those of cutting operations and soil conditions take first place in importance as causing windfall damage, fungi second, and exposure third.

The principal fungi concerned in causing windfall are *Polyporus schweinitzii*, *Trametes pini*, *Echinodontium tinctorium*, *Fomes annosus*, *Armillaria mellea*, and *Sparassis radicata*.

Fungi as secondary causes play an important part in causing windfall. Poorly drained soils, moist sites, old-age class, fire, and other injuries, prevalence of fungous infection, all contribute to increase the weakening action of fungi exerted upon the roots and trunks of trees and thus increase the danger and damage from windfall.

All other factors being equal, a sound tree will withstand windthrow when a tree whose roots are rotted will be thrown or a tree whose trunk is rotted will be broken.

A large amount of damage to our National Forests and the remaining forest region as well, reckoned upon a financial basis, is annually sustained through windfall. A considerable portion of this loss can be traced to fungous action alone.

Fungous attack is largely responsible for windthrow in western white pine, one of the most important of our timber trees. It is also a menace through windthrow to all stands of infected timber left as thinned stands or as seed trees after cutting operations.

It is recommended not only as a measure toward increasing forest sanitation, but primarily as a preventive measure against windfall and windbreakage, that all trees marked to be reserved in selection cuttings or as seed trees upon a cut-over area are to be free from root, butt, and trunk rots.

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REVIEWS

Tropismen und excentrisches Dickenwachstum der Bäume. By Arnold Engler. Beer & Company, Zurich, 1918. Pp. 106 2°. Price, frcs. 10.

This prize essay by the well-known director of the Swiss Forest Experiment Station is the result of eighteen years' systematic observations, tabulated measurements, and experiments to account for the eccentric growth and form of trees under various conditions.

While considerable theoretical interest attaches to this problem, it is not without practical interest, especially in the practice of thinnings.

In the introductory five pages the author briefly rehearses what other authorities have produced regarding geotropic, heliotropic, and other influences on the uneven development of diameter growth and form.

His own observations show that twigs, branches, and even stout stems of all broadleaf and coniferous species, are capable of *geotropic* curvatures, so that a more than 5-inch stem, brought out of vertical position, can erect itself and re-establish verticality. Reactions of such nature to *heliotropic* stimuli are also observed in broadleaf branches and stems, but not in coniferous several years old. In the former species, both geotropic and heliotropic curvatures are very frequent, and account for the form of their crowns. This reaction of older woody parts is, however, induced by or in relation to the young shoots. It is due to this ability that broadleaf trees bend and grow into the openings made by thinnings, while spruce and fir do not respond in the same way.

To the peculiarities of form in broadleaf trees on steep slopes a special chapter is devoted. On such slopes, in even-aged, close stands, as a rule, will be found a strong curvature at the base, convex toward the valley; then the branchless part is found straight, but leaning valleywards, and the top curving from the base of crown, concave toward the valley. This form is also assumed by pine and larch; only in fir and spruce on steep slopes vertical position, as taught in text-books, is found. The influence of different methods of thinning on form is discussed.

Gravity and light are the causes of form, which on steep slopes do not work in the same direction, the light being more one-sided, and curtailed on the upper side. Since the trees on such slopes are leaning downward, and are also more heavily branched on the downward side, one would expect a larger diameter development on the down side. This is, however, not quite so; in broadleaf trees, at least at the base, the upper side radius is usually larger than the lower side, and this eccentricity reaches considerably above breast height.

The author explains this behavior as a reaction to geotropic stimulus. For conifers, leaning or one-sidedly loaded, the stimulus of compression on the cambium accounts for the increased diameter growth on the lower side; also in part in broadleaf trees. Tensile forces have no effect, since in that direction the strength of wood fiber is greatly in excess of compression strength. Gravity is of influence on diameter development of the lower stem parts only when it has been active on the young shoots, as, for instance, when, due to light influence, the plant had taken a leaning position.

A series of experiments with 3 to 10 year-old trees, forcibly bent, was used to show that bending woody shoots of broadleaf kinds always is accompanied by increased diameter growth on the compression (concave) side, the largest at the most severely bent part.

A chapter is devoted to the character of the wood formed under the stimulus of gravity and compression.

The summary brings in twelve theses the results and conclusions. Besides those we have already mentioned, we may add the following: The ability to react to light and gravity is not possessed by all parts of the tree alike. In the younger (higher) parts of stems the light stimulus; in the lower parts the gravity stimulus preponderates. The place of reaction may be situated at a distance from the place where the stimulus is felt, so that the basal parts may react by geotropic curvature and eccentric diameter development to the gravity stimulus on the growing end-shoots.

The compression stimulus seems not to influence the summerwood formation and histological character of the wood, but it increases the volume increment. In ring-porous woods, however, the geotropic wood shows broader porous area and relatively more summerwood, and in drying shrinks more longitudinally than the wood of the underside.

While classifying the forces at work, as is here done, advances our knowledge of tree growth to some extent, we are really not yet informed regarding the physiological processes active in the development of these phenomena.

The author suggests, however, that the curvature and other changes of formed wood can take place only due to activity of plastic material on both convex and concave sides, and recognizes as such the living wood parenchyma which accompanies wood fibers and forms the pith rays, and which is connected with the cambium and younger wood. This accounts also for the more ready response of the broadleaf trees, which are more fully provided with this plastic material. In proportion to the presence of these living cells tropistical movements become possible in response to gravity (geotropism) and light (heliotropism).

B. E. F.

Western Yellow Pine in Oregon. By Thornton T. Munger. Bulletin No. 418. U. S. Dept. of Agriculture, Forest Service. February, 1917. 48 pp.

Statistics showing the relative importance of western yellow pine as a commercial timber tree, with particular reference to Oregon conditions, are given in the opening pages. Yellow pine covers more area in the State than does Douglas fir, but owing to its lighter yield per acre (7,000 board feet) has only 25 per cent as much volume. As indicated by a map giving the commercial and botanical ranges of yellow pine in Oregon, the tree is restricted commercially to the region east of the Cascades, except in the southwestern corner, where it is found on the Siskiyou Mountains and west slope of the Cascades. Munger divides the commercial range into three sections:

	Acres of commercial yellow pine.	Total stand in thousands of feet b. m.
Blue Mountains	4,276,000	31,350,000
East Slope Cascades	3,400,000	33,185,000
Southwest Oregon	2,330,000	6,830,000
Total	10,006,000	71,365,000

Of these totals, approximately 4,448,026 acres and 34,812,400,000 feet board measure are privately owned, while 5,543,480 acres and 36,489,700,000 feet board measure belong to the Government.[1] Several pages are devoted to paragraphs on "descriptions,"[2] climate, soil and soil moisture, light, seed production, germination and development of seedlings. Seedlings are found most abundantly "on the exposed spots in the forest, such as on scabby ridges, where the mineral soil is naked. Here germination may be the best, but the mortality of the seedlings the first year is the largest." . . . "The seedlings that ultimately

[1] Includes timber on two Indian Reservations and a small amount owned by the State.

[2] Deals with size, form, root-system, character of the tree, etc.

succeed are those in the gaps between the clumps of old trees or beneath those which have recently died." The effects of fire are well presented and discussed at some length. Although the fires are mainly light surface fires, the aggregate damage is enormous and is classified under the following headings:

(1) Fire scarring of the butts of merchantable yellow pine; 42 out of every 100 trees were fire scarred, as determined by a careful cruise.

(2) The killing of occasional trees by the burning through of the base. The average fire "on land which has been periodically burned over before kills in this way one merchantable tree on from 1 to 4 acres."

(3) The pitching of the butts of commercial trees. A tally of 1,184 showed 25 per cent of them "pitched."

(4) The impoverishment of the soil by repeated burnings.

(5) Destruction of the reproduction which should form the basis for the next crop.

(6) Degeneration in the forest type. In parts of the State fires may effect a transformation from yellow pine to lodgepole.

Other sources of injury, such as insects, vegetable parasites, the elements, and animal life receive attention. In discussing wind damage Munger says: "Where the trees are in groups, the wind damage is considerably greater than where the reserved trees are evenly distributed. The effect of the wind is particularly severe in a solid body of uncut timber along the lee edge of a cut-over area." Yellow pine may be classed both as a rapid-growing and as a slow-growing tree, depending on the region in which and the condition under which it grows. Southwestern Oregon is the region within the State where growth is most rapid. Central and eastern Oregon yellow-pine timberlands are considered capable of producing from 75 to 175 feet board measure per acre per year. Only in the last ten years has yellow pine in Oregon been extensively lumbered. In addition to their lumber value, yellow pine stands are capable of supporting one sheep to each 3 acres or one cow to each 15 acres.[3] Due to cold nights and a short growing season turpentining of yellow pine, tried experimentally, is considered impracticable under present conditions. Logging by horse and railroad is the prevailing method of getting logs to the mills. This method is adapted to the timber and the country. Of the mills cutting chiefly yellow pine (100 in all), only four have a capacity of 80,000 feet or more per 10-hour day. Planting is preferred to direct seeding. Small 2 to 3 year-old trees should be used. For proper management of the public forests of yellow pine four lines of work must be carried on:

[3] Holds principally for eastern and central Oregon.

(1) Protection of the virgin forest from fire. Since the forest is many aged, absolute fire protection is necessary to secure reproduction.

(2) The cutting of the mature trees in such a way that the immature trees will be spared from injury. The selection system of cutting is advised in order to prevent exposure and drying out of the soil, foster reproduction and create conditions suitable for the best growth of yellow pine at all ages. 10 to 30 per cent of the volume of the stand (above 12 inches in diameter) is left.

(3) The intensive utilization of all the merchantable timber designed for cutting.

(4) Proper disposal of the logging debris in order to make possible the subsequent protection of the stand of immature timber from fire.

Piling and burning is the best method, and costs 25 cents a thousand feet for piling, with a few cents to be added for burning. Private owners cannot be expected to handle their lands just as the Government is doing. They are urged to protect the virgin and cut-over timberlands from fire, to pile and burn brush, and to exercise care to protect young growth and unmerchantable large pines which may serve as seed trees, and to leave uncut, medium-sized trees which may be unprofitable to log. The appendix contains two volume tables and detailed instructions for marking timber and disposing of brush. The bulletin is above the average in clearness, conciseness, and originality in presentation of material.

R. C. H.

Report of the Chief Forest Fire Warden for 1917, Department of Forestry, Pennsylvania. Bulletin 17. 1918. Pp. 112.

The Pennsylvania Department of Forestry has had for the last three years a special bureau of forest protection, with an organization of fire wardens appointed under oath, presided over by a chief fire warden. This third report shows that the organization is not yet satisfactory, owing largely to insufficient appropriations, which, according to the fire warden, should be not less than $100,000 for two years instead of the allowed $45,000, which was nearly exhausted in the first year, 1917, being the worst year experienced.

The report brings in great detail, tabulated and with maps, the record of fires, causes, damage, and expenditure.

It is still necessary to carry on educational propaganda, and the warden is most active in forwarding it.

We note the following facts as giving an idea of the state of conditions: The number of fires was practically double that of any of the previous two years, but with less area and damage, namely, 2,087 fires, covering an area of 320,000 acres, and $620,000 damage, over $30,000 having been spent on extinction.

Among the causes we find still 36 per cent due to railroads, a cause which it should be possible, especially now with Federal authority, to eliminate almost entirely. Proportioning unknown causes, which represent nearly 30 per cent of all, the warden estimates that railroads were responsible for 50 per cent, and that altogether 95 per cent could be avoided.

Protective associations, which elsewhere, especially in the West, have become such efficient factors, are as yet but poorly represented, the State's contribution to their expenses being little over $1,000.

Both as regards associated effort and protection against railroad fires the experience of Canada is worth studying.

Legal redress under present laws is difficult to secure; even the criminal law is believed by legal authorities to be inapplicable.

In the way of preventive measures there seems more reliance placed on patrols than on watch towers. The installation of two such is reported, and that without telephone connections, which almost destroys their usefulness, and when it is added that at no time of the year were 100 patrolmen engaged and the whole patrol service did not spend $4,200, it is not a hopeful situation.

B. E. F.

PERIODICAL LITERATURE

BOTANY AND ZOOLOGY

Thick-barked Fir

Huffel records the existence of a specimen of silver fir with a bark resembling that of an old Scotch pine in the State Forest of Elieux, in the Vosges Mountains. The tree is 16 to 20 inches in diameter and is a very rare case. Being within a few hundred yards of the German trenches, its continued existence is somewhat precarious.

Revue des Eaux et Forêts, June, 1917.

SILVICULTURE, PROTECTION, AND EXTENSION

Larix leptolepis

Experience with the Japanese larch (*Larix leptolepis*) in England for fifteen years is reported by Sir Hugh Beevor. Apparently it is more tolerant than the European larch and yet more rapid, but suffers more from drought. Freedom from disease (*Peziza*), vigorous and rapid growth, promises a profitable crop in forty years.

Quarterly Journal of Forestry, April, 1918, pp. 117-20.

Changes in Mixed Forest

The mistakes of the silviculturist are brought out by Biolley in describing what had become of a plantation in the State Forest of Neuchâtel, made some fifty years ago with a mixture of beech and spruce, three rows of each alternating, the rows about 5 feet, spaced 4 feet in the row. Usually in such a mixture, due to the rapid juvenile development of the spruce, the latter becomes dominant. In this case the beech had crowded out the spruce, and even the median row of the latter had suffered from the neighbors of their own kind. Practically the mixture had become pure beech, and that of inferior character, without a future. In trying to find reasons for this change, the author points out that the spruce was outside its climatic habitat, where the beech was at home;

that the mixture was not satisfactorily made by the arrangement in rows, and used too many spruces, but mainly that a timely and judicious thinning practice had failed to assist the development of the stand. Possibly the soil, having been farmed, was unsuitable for the surface-rooting spruce.

Journal Forestier Suisse, May, June, 1918, pp. 84-88.

MENSURATION, FINANCE, AND MANAGEMENT

Modern Organization

At the end of a long discussion on the reorganization of the Forest Service of the Canton of Neuchâtel, just accomplished, the reviewer formulates the aim of the management, which is entirely modern and of special significance. It is not any more "to assure the sustained yield," but to pursue "a continuous progressive production." That is apparently meaningless, and yet it contains in germ an entire revolution, which may mean the end of the "revolution" (rotation) as a principle of management. It signifies, in effect, that the management is to cease being doctrinaire, leave off scholastic forms, and become experimental. It does not concern itself any more with calculating the summary increment of the forests and basing on it a fixed felling budget (*possibilité*) which is to regulate the treatment, but rather to apply a treatment to the forest, watch and study the accretion in relation to the treatment, designed to bring each stand on the road to maximum continued increment. It concerns itself with developing the production by methodical and continued study of the variable influences on accretion and deriving from it hints as to treatment. This study, for which periodic detail inventories will furnish the material and the revisions of which in short periods will act as sign posts, obliges to make one homogeneous body of treatment and management.

The whole economics of the seven articles of the law having reference to the management and its frequent revisions tend to make the permissible felling budget (*possibilité*) not any more the regulator of the utilization. The treatment, silvicultural as well as technical, economic as well as commercial, secures by these legal dispositions a liberty of action such as a science which is based entirely on observations and their application—that is, on experimentation—requires, a science which to bring out its results requires as much art and intuition as knowledge—a science which is at the same time a productive industry.

It becomes allowable to the manager, kept on his guard by frequent revisions, to determine for each stand not an operation prescribed a long time ahead by a felling plan based entirely on age, but the operation actually adequate to its constitution, its cultural condition. This is the technical advantage. But there is also an economic and commercial advantage, in that the manager has permission to decide on an excess cut, although for the moment prejudicial to the progress of increment, and to make this cut at the most profitable time, taking advantage of market conditions.

The predetermined annual budget is only to determine the amount of correction necessary. The law provides, however, that if the permissible cut is exceeded, the returns be placed in a special forest reserve fund, from which to eke out the forest income in lean years, or make extraordinary appropriations for improvement, etc. Reducing the cut in unfavorable market conditions is, of course, also permissible.

La nouvelle loi forestière du canton de Neuchâtel. Journal Forestier Suisse, January, February, 1918, pp. 8-11; 21-5.

Douglas Fir Production

Sir W. Schlich reports measurements of a quarter-acre demonstration planting at Oxford on gravelly, loamy sand, ten years from planting, spaced 4 by 4:

	Before thinning.	Taken out in thinning.	After thinning.
Number of stems	2,548	412	2,136
Average height in feet	25.8	20	26
Average diameter at 4 feet 3 inches, in inches	2.9	1.7	3.0
Basal area at 4 feet 3 inches, in square feet	113.18	4.10	109.08
Volume of timber down to 3 inches diameter at small end, cubic feet in the round	922	31	891

This makes the annual product of wood over 3 inches 92 cubic feet, to which is to be added smaller wood of 67 cubic feet, making the total increment 159 cubic feet per acre per year.

Forestry Statistics—the Douglas Fir. Quarterly Journal of Forestry, April, 1918, pp. 98-9.

French Forestry

Due to the fact that many of our foresters operate in the French forests during the war, even quite local matters in the French forest administration become of interest to us. Fear of overcutting and actual overcutting, the result of war needs, agitates the French foresters and forest owners. The pineries in the Landes have lately particularly come into consideration from this point of view, as the cutting for lumber and mine props threatens to interfere with the naval-store industry. To meet this danger a special council has been created for the two departments involved, whose advice must be sought by the general commission instituted to supervise the logging for war needs.

In the southern departments the cutting of olive trees for fuel, threatening curtailment of the oil industries, causes apprehension, the high price for fuel stimulating this procedure. The increase of game and obnoxious animals is another cause for concern and a let down of restrictions on the chase, increase of premiums for destruction of wild boar, etc., is advocated.

Revue des Eaux et Forêts, May, 1918.

New Dendrometer

Mr. Donald Bruce has devised a simple instrument which will measure the diameter of trees at points out of reach from the ground. The evident practical usefulness and the requirements of such an instrument are discussed. The instrument consists of a straight arm upon which are mounted two small mirrors, both at an angle of 45 degrees with the arm, parallel to and facing each other; one mirror fixed, the other sliding on the graduated arm. The direct line of sight to one edge of the tree passes over the fixed mirror, while the indirect line of sight is reflected in each of the two mirrors, and is secured by sliding the loose mirror until the other edge of the tree is sighted and its reflection is in straight line with the fixed sight. The distance between the two mirrors is the required diameter.

As advantages of the instrument—not quite properly called dendrometer—are stated its direct reading, its independence of distance from the object, and the possibility of locating a given diameter, its rapid use, its portability, light weight, and convenient shape. The objections are that it can measure only a moderate range of sizes, and while very accurate for a hand instrument, it is not capable of extreme precision. These deficiencies are explained and means for partly overcoming them suggested.

Thirty inches seems the practical limit of this caliper. A modification is suggested for timber-survey crews for establishing a fixed top-cutting diameter.

A New Dendrometer. University of California Publications, Vol. III, No. 4, November, 1917, pp. 55-61.

Form-variations of Larch

This article is the result of extensive stem-form studies carried on by L. Mattsson, of the Swedish Institute of Experimental Forestry, on material taken from the large collection of sample trees of European and Siberian larch of the Institute. These trees are measured in sections of one meter, with the first measurement at 0.5 m. above stump. The diameter of the stump and at breast height (1.3 m.) and the thickness of bark at all sections is also measured. Mattsson divides the stems into form classes and height classes, and works out average values of the diameter quotients at the different cross-sections on the stems for each of these classes. The height classes were based on the unit length of one meter and the form classes were obtained by means of the Janson "absolute form quotient"—that is, the diameter at the middle of the stem above breast height divided by the diameter at breast height. The values for each form-height group were plotted on cross-section paper and the diameter quotients read off on the rounded curve at every 10 per cent of the height of the stem above d. b. h. From these data a general taper series was worked out applicable to all trees of a certain form quotient and illustrating the form of the stem inside bark and above d. b. h. In the final series the influence of root swelling was eliminated.

Among the important results of the investigations are:

(1) The general construction of the stem of the two larch species examined is quite the same.

(2) The taper series obtained by Mattsson agrees almost entirely with the taper series worked out by Professor Janson for Scotch pine.

(3) The form-class variation within a stand is very great. The amplitude does not seem to vary with any particular character of the stand.

(4) The form-class curve within a stand shows a slight drop with increasing d. b. h.

(5) The mean form class of the stand is very closely related to the mean height.

Where any deviation from the form class determined by the mean height can be demonstrated, this deviation can be explained as due to the density of the stand during the period of best growth. The mean form class of a stand is therefore to be determined with sufficient accuracy for all practical purposes from the mean height of the stand. Should greater accuracy be desired, the density during the time of growth, determined by comparing the mean diameter of the stand obtained by measurement and the mean diameter which by empirical knowledge was to be expected, must also be taken into consideration.

The thickness of bark at breast height and the taper of the bark with increasing height on stem is thoroughly investigated. Series of relative bark percentages breast high were obtained from all sample plots and an average relative series was worked out. By means of this series the bark percentage for each diameter class in a stand can be found as soon as the value for one class is known. It is found that the bark percentages breast high decrease with increasing d. b. h. The general thickness of the bark in different stands varies a good deal, this being considered due, probably, to the difference in the origin of the seed. Taper series for the bark of trees of different height classes were reduced in the same manner as was before used in dealing with the taper of the stem. Since the taper of the bark is a quality quite independent of the taper of the stem, the absolute form quotient was put aside and the bark quotient at the middle of the stem was used as a measure of taper.

Having obtained taper series for stem and bark, Mattsson works out for each form-height group breast height form factor for the stem inside bark and for the bark relating to the cylinder inside the bark. A table showing the volume of bark in percentage of the volume of stem inside bark for stems of different form quotients and bark quotients at the middle of the stem is also worked out.

H. C.-W.

Meddelanden från Statens Skogsförsöksanstalt, 1917, pp. 843-922.

UTILIZATION, MARKET, AND TECHNOLOGY

Fuel Value of Wood

W. B. Campbell, of the Canadian Forest Products Laboratory, explains in simple language how the fuel value of woods is determined. As the subject is nowadays of increased interest, we quote in full:

For every combustible substance there is a corresponding "heat of combustion," which is invariable for that substance and is expressed as the number of heat units, or B. T. U.'s (British thermal units), given off by the combustion of one pound. This quantity is the same, no matter how slowly or how rapidly the combustion takes place, and it has no direct reference to the temperature of the fire. If combustion is rapid, a large number of heat units are produced in a short time and consequently the temperature is high. If combustion is slow, the number of heat units per second is small and the heat gets a chance to become dissipated; consequently the temperature is low.

If a fuel is wet the water must all be evaporated during the burning of the fuel, and this takes away some of the heat. To heat up a pound of water from the ordinary temperature to the boiling point, evaporate it, and heat the steam to the temperature of the chimney gases requires about 1,220 B. T. U. Consequently for every pound of water in the fuel this amount of heat goes up the chimney. This loss is present to a greater or lesser extent with all fuels, but is particularly important with wood. Coal may contain 2 or 3 per cent water, or 40 to 60 pounds per ton. Green wood may contain 1,500 to 2,000 pounds of water per cord. Air-dried hardwood holds about 720 pounds per cord. The reason for demanding well-dried wood is therefore quite obvious.

The next statements may not seem quite so evident, but they are equally true. The "heat of combustion," or "calorific value," is, within narrow limits, the same for all woods—that is, a pound of one wood will give off almost exactly the same amount of heat as a pound of a different wood. This does not mean that a *cord* of one wood will give the same heat as a cord of any other wood, because one cord may be much heavier than the other. Some woods are highly resinous—red pine, for instance—and these have a slightly higher heating value on this account, but the difference is not great. The reason for all woods having equal calorific value, is not far to seek. Fundamentally, all woods consist of the same substance, and one species differs from another chiefly by the way this is arranged in the wood structure. Since all woods *do* consist chiefly of the one substance, the calorific values of all of them must be the same. Measurements of the calorific value show that one pound of *perfectly dry* wood yields 8,220 B. T. U. For comparison, it may be stated that one pound of good hard coal yields about 12,000 to 13,000 B. T. U. and poor coals go very much lower. Perhaps it would be better to compare these in terms of cords and tons. One cord of air-dried maple or birch will contain about 3,250 pounds of dry wood and about 720 pounds of moisture. Its heating value will then be: 3,250 × 8,220 = 26,715,000 B. T. U., less 1,220 × 720 = 878,400 B. T. U., giving a net heating value of 25,836,600 B. T. U. A ton of coal gives a net heating value of 2,000 × 13,000 = 26,000,000 B. T. U. These two values are very nearly equal, so that we can say that *one cord of well-dried hardwood* (beech, birch, or maple) *is equal to one ton of good, hard coal.* Other woods have heating values in proportion to their weight per cubic foot.

The following table shows the number of cords of various common woods required to equal one cord of well air-dried hardwood or one ton of coal:

	Cords		Cords
Ash	1.10	Poplar	1.55
Basswood	1.70	Cedar	2.10
Beech	1.00	Douglas fir	1.20
Birch	1.00	Balsam fir	1.80
Butternut	1.60	Hemlock	1.60
Elm	1.00	Jack pine	1.50
Maple	1.00	Spruce	1.60
Oak, red	0.97	Tamarack	1.15
Oak, white	0.93		

Another point worth bearing in mind in connection with the burning of wood in place of coal is the difference in the amount of ash produced. A cord of hardwood will make only about 60 pounds of ashes, while a ton of hard coal will make from 200 to 300 pounds; judging from the grade of hard coal coming to Canada during the past winter, 1917-18, the latter amount is more likely, and some lots will run even higher than this, especially the small "steam sizes." The calorific value of these latter may frequently be as low as 10,000 B. T. U. in place of the 13,000 B. T. U. used in the above calculations.

Canadian Forestry Journal, April, 1918, pp. 1632-3.

Moisture and Strength of Timber

A series of experiments to determine the effect of moisture re-absorption upon the strength of air-dried timber has recently been concluded in the testing materials laboratory of the Massachusetts Institute of Technology. The series included parallel tests upon southern yellow pine and Douglas fir. The material tested was obtained from 4-inch planks, obtained in the local markets, which were dried in the air to an average moisture content of 6 to 8 per cent. Two inch by 2 inch by 20 inch sections were selected from the planks. Two 2 inch by 2 inch by 8 inch test specimens were cut from each of these sections. One 8-inch specimen was immediately tested in an air-dry condition, while the contiguous specimen was allowed to re-absorb moisture before it was placed in the testing machine. This procedure was repeated until a sufficient amount of data was obtained. The specimens were allowed to re-absorb moisture either by immersing them in water at 70° F. or by placing them in saturated air at a temperature of 120° F. for varying periods of time.

It was determined that in saturated air at the temperature named above the wood re-absorbed moisture until the fiber saturation point was reached, and the author concludes that "timbers subjected to the action of saturated air at 120° F. must be designed on a basis of constants determined from tests on green timber." In the case of Douglas fir, the specimens subjected to saturated air at this temperature had a compressive strength of only 75 per cent, as compared with air-dry timber. Submersion in water lowered the compressive strength approximately 40 per cent. Southern yellow pine showed a much more rapid decrease in strength, the specimens subjected to saturated air having a compressive strength of only 65 per cent, as compared with air-dry timber, while immersion in water lowered the compressive strength approximately 60 per cent.

The author draws the following conclusions:

1. "In the air-dry condition, with approximately equal moisture contents, the compressive strength of hard pine is about 25 per cent greater than Douglas fir." [Reviewer's note: Evidently doctors disagree. The U. S. Forest Service, in Bulletin No. 556, states that in compression parallel to the grain the maximum strength of Douglas fir (pounds per square inch) is 10,680, while longleaf pine has a crushing strength of 10,880. In compression perpendicular to the grain, Douglas fir shows a fiber stress at the elastic limit of 1,270 pounds, while longleaf pine shows a fiber stress of 1,640 pounds.]

2. "When exposed to air saturated with water vapor at 120° F. and when immersed in fresh water at 70° F. the moisture re-absorption of air-dried wood is greater and more rapid in the case of fir than of pine."

3. "The temperature effect on strength decrease is of more importance on pine than on fir."

4. "Pine shows a more rapid decrease in strength with the moisture decrease than does fir. The more rapid re-absorption by fir tends to offset this effect when the time element is used as a basis, so that for a given treatment the pine remains the stronger, although the strengths tend to approach each other with more extended treatment."

5. "For moisture contents above 11 per cent, when due to re-absorption from air saturated at 120° F., the fir is stronger in compression than pine. The same relation appears for moisture contents greater than 20 per cent when due to soaking in fresh water at 70° F."

B. L. G.

Effect of Moisture Re-absorption on Compressive Strength of Air-Dried Timber. I. H. Cowdrey, Journal of the American Society of Mechanical Engineers, XL, May, 1918.

EDITORIAL COMMENT

The Loyal Legion of Loggers and Lumbermen

When we entered the war it was seen that the task of supplying ourselves with airplane wood would fall chiefly on the Pacific lumber camps. Hence the Government's first step was to form the Spruce Production Division of the United States Signal Corps, with headquarters at Portland, Oregon, and Colonel Brice Disque, U. S. A., in charge.

Colonel Disque found that labor conditions throughout the logging camps were in a state of chaos. Labor agitators and I. W. W. fanatics were doing everything in their power to demoralize conditions. Strikes and other indications of economic unrest were of every-day occurrence.

As an offset, Colonel Disque organized the Loyal Legion of Loggers and Lumbermen. With the Government's authority, he followed this up by fixing the price of lumber and wages and inaugurating an eight-hour day. Today the Loyal Legion of Loggers and Lumbermen has over a hundred thousand members, and the number is steadily increasing. Strikes are unknown, and for the first time in their history the national flag waves over six hundred logging camps in the forests of the Pacific Northwest.

A prime agent in the accomplishment of this superb result has been the publication by Colonel Disque, under Government authorization, of a "Monthly Bulletin," so as to bring the different "locals" closer together and to keep before them the importance of their place in the world's struggle. Under the editorship of Mr. Spencer Best, this United States Army publication has been an unqualified success. It reaches every part of the Northwest forests.

Forest Reconstruction Program of England

The report of the forestry subcommittee of the Reconstruction Committee of England lays stress on the need for conserving and augmenting the supply of home-grown timber. The adoption of a state afforestation policy, both as a measure of war precaution and a means toward national improvement and social benefit, is urged.

The report states that "the war has disclosed no demand which could not have been satisfied by timber grown in this country, with its favorable soil and climate and abundance of waste land. It is only a question of time before the whole of the country's growing timber which is fit for commercial use must disappear. This country was poorer in timber at the beginning of the war than any European country except Portugal and will be more destitute at its close. Even if every acre felled is replanted, it will be many years before the present output can be repeated."

The afforestation scheme proposed is to plant 1,770,000 acres on an 80-year rotation, when two-thirds of the whole should be planted within the first 40 years.

State planting is recommended, the total cost for the first 10 years to be about £3,500,000, including the initial cost of planting and charges for administration, education, and research, upon an estimate that there are not less than three and probably more than five million acres of rough grazing land also capable of growing first-class timber without encroaching on food-producing land. The commissioners estimate that by afforesting two million acres England should be not only self-supporting in timber within 50 to 60 years, both for military and commercial purposes, but to a great extent independent of imported timber; and further results would be: (*a*) The retention of money at home for expenditure on a home industry of great importance, and (*b*) profitable utilization of very considerable areas of land now almost entirely unprofitable.

Beginning with the fifteenth year, pitwood from the quicker-growing species on the better kinds of mountain land should be available; by the fortieth year pit supplies for two years, at the present rate of consumption, should be obtainable from plantations made in the first 10 years.

The scheme should be self-supporting after 40 years, by which time £15 million may have been paid out, this sum being less than half the direct loss (£37 million) incurred during the years 1915-16 through dependence upon imported timber.

The work is to be in charge of a Forestry Commission (represented in the House of Commons), composed of six members—three whole-salaried officials and three unpaid—and consultative committees for England, Wales, Scotland, and Ireland are to be appointed. The commission would undertake the general control of forestry education and maintain "demonstration woods" for practical work.

It is estimated that work would be provided for not less than 25,000 families; also a tonnage to the sum of 7,000,000 net tons of shipping.

equivalent to 14,000,000 tons dead weight (according to statistics of timber importations for 1915-16) would be saved.

Announcement has been made that the Minister of Reconstruction is now giving careful consideration to this report, with a view to ascertaining how far and by what means effect may be given to the recommendations of the forestry subcommittee.

Eastern Spruce for Airplane Manufacture

Eastern spruce has for some time been used for airplane construction in the United States, although only a very small percentage of this timber is sufficiently clear for this purpose. Tests made by the United States and Canadian governments show that where material of suitable quality can be found, Eastern spruce serves admirably for airplane construction, and may be expected to supplement in a very valuable way the supplies of Sitka spruce from the West.

The Imperial (Canadian) Munitions Board has now taken up the question of securing in eastern Canada as large an amount as possible of Eastern spruce of the grades suitable for airplane manufacture. This work is being carried on in co-operation with limit-holders and sawmills, and a foundation is being laid which will undoubtedly result in the spruce of eastern Canada becoming a valuable contributing factor toward winning the war in the air.

The material for this purpose has to be sawed parallel to the bark, instead of parallel to the axis of the log, as is done for lumber. In this way, straight-grained boards are obtained, having the highest possible percentage of material free from knots and possessing a maximum of strength.

Timber Resources of the British Isles

An erroneous idea as to the British timber resources seemed to prevail before the war, according to a London trade paper. It seemed to be the opinion that the coal mines were dependent on supplies of pitwood from overseas, and that in the absence of their importation further operations would be impossible. Although the country has been at war for four years, no shutting down has occurred. In 1917 approximately 995,000 loads of mining timbers were imported, as against an importation of 2,477,000 loads in 1914. This difference was offset by the production of a trifle less than 2,000,000 tons from the British forests. According to the trade paper, recent timber surveys indicate that there is sufficient timber available to meet the demand for some years to come. Sawed wood is now being produced at the rate of 500,000 standards per annum. It is also stated that there are good resources of softwood and enormous quantities of ash, elm, beech, chestnut, etc.

Soapweed Perks Up

A peculiar situation has arisen in the Southwest in connection with the use of soapweed (*Yucca elata*), once a despised member of the family of range plants. Experiments by the U. S. Forest Service have proved the value of yucca as an emergency forage plant, and machines have been developed which cut and slice it before it is fed to the cattle. During the past year, when there was acute shortage of feed in southern New Mexico and western Texas, thousands of cattle were saved from starvation by sliced soapweed. A large cordage and sacking concern in St. Louis, however, has begun to cut this plant on the open ranges, with the object of utilizing the leafy, palm-like tops for the manufacture of rope and bagging. The heavy stalks, containing the best part of the food, are left to lie on the ground and go to waste. Reports have it that the concern is clearing off the land at the rate of six or seven hundred acres a day. Since indications are that it will take anywhere from six to ten years to reproduce another crop of soapweed mature enough for profitable cutting, the stockmen in the Southwest regard the operations of the St. Louis concern with a good deal of apprehension. All of which goes to show that soapweed is at last coming into its own.

New Limbs for Old

At the request of the Surgeon General's Office, the U. S. Forest Service has made a study of the artificial limb industry. The Surgeon General estimates that for each 1,000,000 men on the firing line there will be needed 1,000 artificial limbs each month. It is planned to provide the injured with temporary limbs as soon as possible, and to fit them with permanent ones upon their return to this country. Industrial Investigations is conducting experiments looking to the perfection of a type of temporary limb. Willow is the principal wood used for artificial limbs, and the raw material is usually air seasoned from two to five years. While there is no scarcity of willow at present, the quantity of air-seasoned wood available is very limited. Through the laboratory and co-operative manufacturing establishments experiments in kiln-drying green willow bolts are well under way.

NOTES

Wind Shake in Douglas Fir Timber

In my work with timber sales upon the Flathead Indian Reservation, Montana, I have made a somewhat brief examination of wind shake found in Douglas fir timber.

Most of the trees were found on deep soil of good fertility and in mixture with yellow pine, on a slope having a northeasterly exposure. Timber on this area cuts from five to seven logs to the tree. About 42 per cent of the trees examined indicated the presence of ring shake. Only 50 trees were examined, but from my brief studies I have drawn the following conclusions with respect to this area:

1. The worst cases of wind shake were found in the more secluded pockets and protected areas. Indications point to the fact that such trees are tall and straight grained, and are therefore less able to resist the sudden gusts of wind that often visit these pockets.

2. Douglas fir trees grown on ridges are less subject to wind shake than those grown in the pockets. I have examined trees grown on ridges, and have found them free from shake, although cutting five logs to the tree.

3. Shake is not always found in the butt. It may occur at any point in the tree. I examined several specimens where there was no evidence of butt shake, but found it well developed in the second and third log.

4. Shake occurs at the point of least resistance. As evidence of this, I found examples where an old scar, or cat-face, had grown over, and shake had developed from that point. In about 60 per cent of the examples of shakiness I also found that it occurred at the point where there was a marked change from *wide to narrow annular rings,* which I conclude must be a point of weakness.

James B. Saxton.

U. S. Indian Service, Arlee, Mont.

Scenic Development Plan for Du Pont Road

At the request of the State Board of Agriculture the U. S. Forest Service has made a plan for the improvement and development, from a scenic standpoint, of the woodlands, forests, and open lands along the DuPont road in Delaware. G. B. Sudworth is the Service representative who made the study of conditions along the road and prepared the plan. The DuPont road, which, when completed, will extend from one end of Delaware to the other, forming a part of the Lincoln Highway, is a gift to the State from E. C. DuPont, the powder manufacturer. The right of way purchased by Mr. DuPont, and deeded to the State, is 200 feet wide. The roadbed is of cement. Some 40 miles of the southern end of the road have been completed and opened to travel. Under the terms of Mr. DuPont's gift the upkeep and control of the road are in the hands of the State Board of Agriculture.

Disposition of Old Ties

The following suggestions as to the disposition of old ties have been issued by the U. S. Railroad Administration:

1. Old ties will be used for lighting fires in engines to such an extent as it may be advantageous and economical, and when such program is determined they will be picked up and delivered at engine houses.

2. Section men, section foremen, or other employes will be allowed such old ties as the roadmaster may allot them for their personal use only.

3. Ties may be given to adjoining farmers in exchange for plowing fire guards, mowing right of way of the company, or for the privilege of erecting snow fences on adjoining land, under direction of roadmaster and division superintendent.

4. Old ties may be disposed of to the public at such places as there may be a demand for them at such reasonable price as may be determined by the proper officers, provided ties can be picked up by the purchaser without expenses to the railway company.

5. On divisions and districts in wooded country, where there is no demand for old ties, and no other divisions where ties cannot be disposed of in accordance with the preceding paragraphs, old ties will be burned under favorable weather conditions so that the right of way will be kept cleaned up.

The *North Woods*, for March, organ of the Minnesota Forestry Association, brings an account of a successfully conducted municipal wood yard at Virginia, Minnesota.

"A considerable tract of birch and maple timber within three miles of the city was purchased at a stumpage cost of about 15 cents a cord.

An 18 horsepower kerosene saw outfit was installed on this tract and enough six-cord racks, divided into two-cord compartments, to take care of all the delivery teams. In this way there was no delay in measuring the wood while the teams waited. The wood was measured up and waiting for the teams at all times. The city teams were used for delivery. Iced roads and a downhill grade to town made it possible to haul two full cords—the minimum delivered to any one address—at a load.

"The office work was handled by a manager in the court house. The city papers advertised the fact that the city had wood for sale at $3 per route for 16-inch wood, $4 for 24-inch, $5 for 32-inch, $6 for 36-inch, and $8 for 48-inch. Full payment to be made in advance. The applicant filled in the order blank at the court house and paid the full price in advance. From these order blanks the daily saw bill and delivery bill were made out and sent to the foreman in the woods.

"The men were taken to the woods in the city truck every morning, paid $3.30 for an eight-hour day, and hauled back to town at night. With the saw bill in hand the foreman knew exactly what was wanted. He sawed to order and threw the wood from the saw directly into the racks, where it was ready for the sleighs till the day's orders were filled. Each night he submitted a report of the wood cut and the expenditure in labor, supplies, and repairs. Thus an exact cost record was always available and a check on the surplus of sawed wood on hand.

"When the wood was delivered the driver took a receipt, which was pasted onto the order blank and placed on file. Thus there was a complete record of the whole transaction and no chance for a misunderstanding. They made it a point to give very full measure and avoid all kicks.

"When the roads broke up in the spring all the surplus wood was hauled down to the city yard, whence it will be delivered through the summer. Three thousand cords were hauled in the course of the season, the equivalent of 60 carloads of coal. At first the cost ran somewhat over the price asked, but as the organization was shaken into better working order the costs were reduced and most of the equipment was paid for out of the first season's earnings."

A new process of recovering sulphur from the fumes of copper smelters promises to be of interest to foresters on two counts—namely, in reducing the damage from the fumes and in furnishing the needed material for the sulphite process in paper-making. At present the lack of ship tonnage to bring pyrites from Spain has curtailed supplies to such an extent that a critical condition exists in the newsprint business, at least of Canada, and warning has been sent out that users of sulphur, like fertilizer manufacturers, may have to be limited to 60 per cent of their normal supplies to reserve its use for explosives. The new method of recovering sulphur from smelter gases is known as the Thiogen process. It can produce sulphur at $12 to $13 and less, while the price for the last ten years has averaged $19 to $20.

The wet Thiogen process is based on the fact that when an alkaline-earth sulphide, as calcium or barium sulphide, either in divided water suspension or in solution, is added to a solution of sulphur dioxide a reaction takes place. The sulphur dioxide must first be removed from the gases by absorption in water or mother liquor. This is accomplished by an absorption tower, after the gases have been cooled and cleared of dust and fume. To this is added the sulphide solution, and the precipitate containing the sulphite, thiosulphite, and sulphur is settled, and the mother liquor returned to the absorption tower. The settled precipitate is filtered and dried. The elemental sulphur and one-half the sulphur from the thiosulphite is distilled and the sulphur vapors are condensed.

Upon recommendation by the Canadian Advisory Council for Scientific and Industrial Research, instigated by the Commission of Conservation, 100 square miles of the Petawawa military reservation, Ontario, an artillery training camp, has been set aside by the militia department as a forest experiment station in co-operation with the Dominion Forestry Branch, to be available, however, for military purposes so far as needed. Petawawa is situated in a typical white-pine district, and, though almost completely logged at an earlier date, there is now a fine stand of young forest growth and a limited amount of larger material. The Forestry Branch will supervise the cutting of fuel, etc., for the camp, observing and regulating the cutting operations for purposes of silvicultural practice in the region. A preliminary survey of the area is being made, a type map prepared, and detailed studies of volume, growth, and reproduction undertaken.

A purchase of 54,672 acres of land for National Forests in the White Mountains, Southern Appalachians, and Arkansas has recently been approved by the National Forest Reservation Commission. These lands solidify the Government holdings, carrying out the Commission's policy to consider only lands tending to block in with those previously approved for purchase, the average purchase price being $6 an acre, the largest tract, one of 31,667 acres, in Polk County, Tennessee, filling out the entire southern end of what is known as the Cherokee Purchase Area. A large portion is well timbered, there being more than 20,000,000 feet of merchantable timber on the entire tract. The first lands to be acquired in Arkansas through purchase of 997 acres block in with lands in the Arkansas and Ozark National Forests, which were created by the reservation of lands formerly a part of the public domain.

A proclamation has been issued by the President to establish three new National Forests in the East, namely, the White Mountains in Maine and New Hampshire, the Shenandoah in Virginia and West Virginia, and the Natural Bridge in Virginia, making a total of five Forests in the Eastern States.

One phase of forest conservation is the elimination of waste in the utilization of lumber. One way to utilize the small pieces of waste lumber has been devised by T. I. Temple, foreman in the Pennsylvania ship-building plant at Portland. The waste pieces are worked up into panels, which are formed by means of narrow cleats pressed into grooves previously cut into the back of each piece, the grooves being cut by machinery and slightly bevelled on one side. The cleats are pressed into the grooves by a convex roller, forcing the edge into the bevel, which will hold them permanently in place, no glue or nails being necessary. The individual panels are bevelled on the sides and fastened to the wall, floor, or ceiling by means of a narrow rail cut to fit over the bevel. In order to make the plan of commercial value, it is necessary that the mills adopt standard sizes and patterns, when it will be possible to make up panels from the various kinds of mill products.

Pennsylvania's State forest nurseries raised more trees last year than ever before, but the number to be planted in State forests this year will probably be less than last year because of the difficulty of securing labor. An offer, however, has been made that any one in Pennsylvania who wants to plant trees may have them for the asking, with this one condition: that application for less than 500 trees will not be filled; that the trees must be actually planted for reforestation in Pennsylvania and not sold; and, of course, the applicant must pay for packing and transportation. The available stock for free distribution is almost all three-year-olds, and include red oak, Norway spruce, European larch, Japanese larch, and of the pines, white, Scotch, red, and pitch. The Pennsylvania Department of Forestry has also offered to the French Government a gift of 4,000,000 forest-tree seedlings, to be used for reforesting the war-ridden portion of the country, subject to acceptance any time within the next year or two. If the offer is accepted, it may be that members of the Forest regiments now in France will be retained to help with the planting.

Burning of slashings during June, July, August, and September of each year so long as the war shall last, has been forbidden by the Montana Council of Defense. In Order No. 9, which has been printed on cloth and posted throughout the timbered regions of the State, it says:

"It appearing to the Montana Council of Defense that, owing to the extremely dry weather conditions now prevailing throughout the State of Montana, disastrous fires are liable to occur not only in the timbered areas, but on the ranges and in the harvest fields, and that in the event of fires originating through carelessness or otherwise, not only will valuable property be destroyed but large numbers of men will be called into service for the purpose of fire fighting; and it further appearing to the council that it is of extreme importance not only that crops and timber shall be protected against fire but that the man power of the State be conserved for the purpose of harvesting and taking care of crops at a time when the danger from forest and prairie fires is greatest.

"Now, therefore, it is hereby ordered by the Montana Council of Defense that during the months of June, July, August, and September of each year, during the continuance of the war in which the United States is now engaged, the burning of slashings, underbrush, timber, stumps, straw, grass, weeds or waste matter of any kind, whether located upon land belonging to the State of Montana, the Government of the United States, railway rights of way, public roads or private property, is prohibited.

"It is further ordered that campers shall, before leaving camp even temporarily, see to it that all camp fires are completely extinguished and the ground around such fire saturated with water or the ashes and coals covered with dirt to a sufficient depth to insure the complete extinguishment of the fire and the safety of adjacent timber and grass."

The Swedish Trade Journal for June contains the following business gossip from Germany:

The so-called "Ungerska Träbanken Kreditinstitutet ung Holzhandler" has decided to increase its capital stock from 40 to 72 million Austrian crowns ($8,120,000 to $14,210,000), partly in order to take over the shares in the Ungarische Holzhandel A. G. and partly for reserve funds for the extraordinary expenses after the war. The lumber business in Austria-Hungary has received a tremendous impetus during the war, as the value of all woods and all lumber products has increased enormously, and, besides, lumber has been used as a substitute for other materials that were not obtainable. The immense forests in the Carpathians, on the borders of Russia and Roumania, have increased in importance for exploitation imports. It is calculated that the forest in the part ceded to Austria by Roumania has a value reaching up in the billions. The question is being considered as to the procedure which would be most suitable to exploiting the territory acquired through conquest.

The following circular of instructions, issued by the roadmaster of the Canadian Northern Railway at Quebec, to section foremen between Quebec, La Tuque, and Chicoutimi, illustrates well the modern co-operative attitude of railway companies in forest protection work:

QUEBEC, May 17, 1918.

ALL SECTION FOREMEN:

In case of fire I want you to assist the fire rangers when called upon.

According to an arrangement between this company and the heads of the St. Maurice and Laurentian Forest Protective Associations in connection with the fire patrol and care of fires in every respect, you will arrange to co-operate with these people by all possible means; therefore, should the fire ranger happen to call upon you for assistance, do everything possible to give him what assistance you can and as *quickly as you can,* because, by acting promptly, fires are often controlled before any material damage is done.

It has also been arranged with fire rangers in certain districts to assist the section foremen in burning grass, old ties, etc., this with a view of showing sectionmen the proper methods of doing this work, and as you are aware, many times when foremen undertake to burn the right of way, they do not always take all the necessary precautions to look after the fire and in many cases this involves a lot of extra work, due to carelessness in burning the right of way.

The object in co-operating with the men employed by the associations named above, is to learn the best methods and obtain the best results, as well as eliminating a lot of trouble. Therefore, I trust you will give all necessary assistance when called upon and be governed by their instructions with regard to fires in the future. As these people are desirous of assisting us in our work, we should also be anxious to assist them in carrying out their part.

A group of Americans, with Prof. J. C. Merriam, of the University of California, as secretary, have banded themselves together to see what can be done to stimulate interest in securing sufficient funds through private subscription to purchase a tract of redwood in Humboldt County, preferably on Bull Creek, containing 5,000 acres or more, now owned by the Pacific Lumber Company. As probably every

American forester knows, the Government does not possess within its National Forests in northern California any areas of redwood where the *Sequoia sempervirens* is to be found. Perhaps it is not generally known, however, that when it was found that the $50,000 set aside by the Federal Government for the purchase of a forest of *Sequoia washingtoniana* was insufficient, the National Geographic Society contributed the balance of the money, thus preserving these magnificent trees for all time.

The movement to obtain possession of this tract of redwood for the nation has been under way for some time and we wish the undertaking all success, for it would be not less than a crime to leave these forests wholly in private hands, where in time they are sure to be sacrificed to the lumberman's axe.

The Canadian Forest Products Laboratories and Department of Mines have investigated the applicability of various wood oils to the flotation process of recovering silver and other metals to make the Dominion independent on supplies from the United States. While from red pine and western yellow pine as serviceable oil could be secured as from southern pine, it would be too expensive on account of the small quantities recovered and no market for the by-products is in existence. Creosote oils from hardwood distillation, now burned under the boilers as waste product, were also found serviceable, and as there are about 1,200 gallons daily produced, there is more than enough of this product for present requirements.

One of the wisest and most beneficial steps taken lately by the Bureau of Forestry at Manila was the revival of the foresters' conference. During the middle part of the administration of Major Ahern, of the Bureau of Forestry—that is, between 1905 and 1910—the foresters were usually called from the field to Manila for an annual conference, but from 1910 up to 1917 this practice was discontinued, and was not revived until 1918. On November 13, 1917, a letter was sent to all the districts notifying the different officers in charge that they would be called to Manila for a conference during the latter part of January.

Trees planted by dynamite show more growth than those planted by pick and shovel. In a particular case dynamite was used to overcome obstacles such as roots of pine trees 150 years old, between which the young evergreens were to be set out; a ledge of rock and mica formation; large stones and compact clay. One third of a stick of dynamite was used for each shot with 1½ feet of fuse; 250 sapling trees were planted in two days at a total cost of $98.50. The next year the trees made a foot of new wood, some reaching 10 feet in height. After two years these trees were a foot taller than trees of larger size planted the year previous with pick and shovel. Out of the 250 trees planted by dynamite only 19 were lost, and that was due to the fact that the year of planting was the driest summer in 40 years.

A very important decision by the Supreme Court of the State of Washington confirms a verdict of an inferior court to the effect that failure to use due diligence in preventing the spread of a fire to a neighbor's property renders the owner of the premises on which the fire starts absolutely liable for damages, regardless of the manner in which the fire starts. The full text of the decision is given in *Forest Leaves*, June, 1918, pp. 132-5, going into considerable detail of argument.

A similar instance in Quebec is cited by the *Canadian Forestry Journal*, July, 1918, p. 1772, in which the Superior Court condemned the plaintiff to pay all damages arising out of a fire he caused, amounting to $8,313.88, and the decision was maintained by the Appeal Court.

A correspondent of London, England, says Canadian foresters have felled the famous tree which stood in front of Windsor Castle, known as William the Conqueror's oak. The tree was reputed to be a favorite of the Norman Duke, who protected it from deer. Old manuscripts show the oak tree existed in the year 900. Latterly the tree became unsightly and was very rotten. After ineffectual attempts to have it reinforced with cement, the King ordered its removal. The timber has very fine grain and color. One slab is used for a mantelpiece in the small replica of a Canadian log cabin built by the Canadians in Windsor Park as a tea room for the King. A number of souvenirs have been made of the wood. One is a carved plaque of Windsor Castle background and Indian's head.

What is said to be the most valuable tree specimen in the world, from a productive standpoint is the Gantor avocado, or alligator pear, near Whittier, Cal. Its average revenue to the owner is $3,000 a year. At one time it was insured in Lloyds for $30,000, but the company insisted that a high lattice fence be built about it to avert any damage from wind or carelessness, and it was feared that this might interfere with the health of the valuable producer and two years ago the lattice work was removed, causing a cancellation of the insurance policy. Other alligator pear trees in southern California produce large returns, but none so far has rivalled the Gantor tree, the fruits from which sell at from 50 cents to $1 each.

The Riordon Pulp and Paper Company last winter conducted a night school for its employees. Classes were held in English, mathematics, chemistry, physics, mechanical drawing, and first aid. No fees were charged, the company bearing all expenses, and members of the technical staff giving their time and services as instructors free. Out of a total of about 50 students who started attending the classes, 33 finished the courses and qualified for diplomas, the remainder being compelled to drop out because of illness or owing to leaving town. This result would appear to justify a repetition of the school this coming year.

French chemists a year or two ago reported the manufacture of toluol, which is much needed now for explosives, from spruce turpentine by subjecting it to the combined action of benzol and aluminum chloride. The process has been checked up through experiments by A. S. Wheeler, of the University of North Carolina, and the experiments are being carried further in the endeavor to improve the commercial yield. The other product of this reaction, cumol, may also be used to produce benzoic acid, which has hitherto been produced from toluol. Spruce turpentine, differing considerably from the ordinary pine turpentine, is not suited to all the same commercial uses.

Senator King has introduced a bill providing that the offices of the Commissioner of Indian Affairs and the National Park Service, the Commissioner of the Land Office, the Geological Survey, the Bureau of Mines, and the Reclamation Service shall be transferred to branch offices west of the Mississippi River, at places to be designated by the President.

Point Pelee, the most southerly portion of Canadian territory, jutting out from the lake shore of Essex County, Ontario, into Lake Erie for a distance of about nine miles, has just been created a National Park by the Dominion Government, to whom the land belonged. The creation of this park for the protection of its distinct and attractive tree and plant life and the wild life it harbors permanently and during certain seasons was recommended by the Commission of Conservation and the Advisory Board on Wild Life Protection; the Canadian Society for the Protection of Birds and the Essex County Wild Life Conservation Association also advocated its creation.

A new source of ink is reported from France—the fungi known as the "ink caps," or "inkstand" or "ink bottle," because, when decaying, a black liquid is produced. A French scientific journal states that extensive experiments in the production of indelible ink from this fungus have been made by French botanists.

The fungi are placed in a container. Upon changing in a day or two into a black, pulpy mass, they are filtered through a folded cloth, yielding a black or brownish liquid. A small quantity of gum arabic and a little essence of cloves added is said to improve the ink and preserve its fluidity.

Special maps are being prepared of practically all the National Army and National guard camps and cantonments. These maps will show the usual topographic features—culture, drainage, and relief—and the boundaries of the camps. They also bear a text describing the historic and geological events that have occurred in the region. The maps of Camp Sheridan and Camp Upton are already available. The maps may be had from the U. S. Geological Survey, Department of the Interior, Washington, D. C., for 10 cents a copy.

"Lalang" grass, which resembles closely the "esparto" of Spain and northern Africa, and which will yield as many as three crops a year, is reported from Queensland, after experimentation, as producing a splendid paper pulp. "Lantana," also a pest in that country, makes an excellent wrapping paper. An expert states that esparto is the best pulp known and that the lalang-grass product is within 10 per cent of the same value.

The United States Civil Service Commission announces open competitive examinations for an engineer in forest products and an assistant engineer to fill vacancies in the Forest Products Laboratory at Madison, Wisconsin. The salary attached is from $1,860 to $3,000 for the engineer and from $1,200 to $1,800 for the assistant. The examination will count education 50 per cent and experience 50 per cent. The duties include the usual investigations in the lumber and paper industry, and the Service will insist on men being graduates of recognized universities or colleges.

The publishing house of Thomas Nelson & Son, of Edinburgh, Scotland, foreseeing a paper famine throughout the world within a few years, has planted about 1,000 acres of land at Trinidad, B. W. I., in bamboo, from which it plans to manufacture paper. The firm is said to have designed a machine which will mash and remove knots from the bamboo, and to have found a dye or bleach which removes the yellowish-green color from the woodpulp and makes it perfectly white.

A United States patent for a machine by E. F. Millard describes a process for making an all-groundwood newsprint paper, in which about 50 per cent of a short-fibered pulp is mixed with 50 per cent of a long-fibered pulp, both being produced by the one machine; the long fibers facilitate the running of the pulp, while the short fibers give strength and finish to the sheet.

War Brevities

A walnut tree on the college campus at Crawfordsville, Indiana, was recently sold for $650 to the W. T. Thompson Veneer Company. The tree will be manufactured into airplane stock and veneers for the piano trade.

A Douglas fir flagpole, 300 feet high, has been erected at Camp Lewis. This smashes the record of a 215-foot Douglas fir flagpole of the Kew Botanical Garden in England, which for years was credited with having the tallest flagpole.

Cub bears are in great demand by the various units of the army in the Northwest as mascots, and the forest rangers of District 1 have been called on to supply the demand.

SOCIETY AFFAIRS

Mr. Frank B. Moody, member of the Wisconsin Conservation Commission, died Monday afternoon, August 19, at St. Mary's Hospital, after a brief illness of pneumonia. He is survived by his wife and three daughters.

Mr. Moody was born in 1880 in the State of Maine. He was raised in the Maine woods and educated in Bates College and the School of Forestry, University of Michigan. In 1906 he went to Wisconsin as Assistant State Forester under Edward Marriam Griffith, remaining in that position six years, when he resigned to become a member of the faculty at Cornell University.

When the Conservation Commission was created in 1915 to take over the duties of State forestry board, park board, commissioner of fisheries, State game warden, and old conservation commission, Mr. Moody was appointed a member and placed in charge of the division of forestry and parks. He was reappointed in 1917 for a period of six years.

Mr. Moody, who had made a life study of the woods, had a wide acquaintance among the prominent foresters of the country. Last winter when the Government issued a call for experienced foresters to enter that branch of the military service, Mr. Moody volunteered and was commissioned a captain at Camp Lee, Virginia. While in camp his wife and two of his children became seriously ill and he was compelled to resign his commission and return home.

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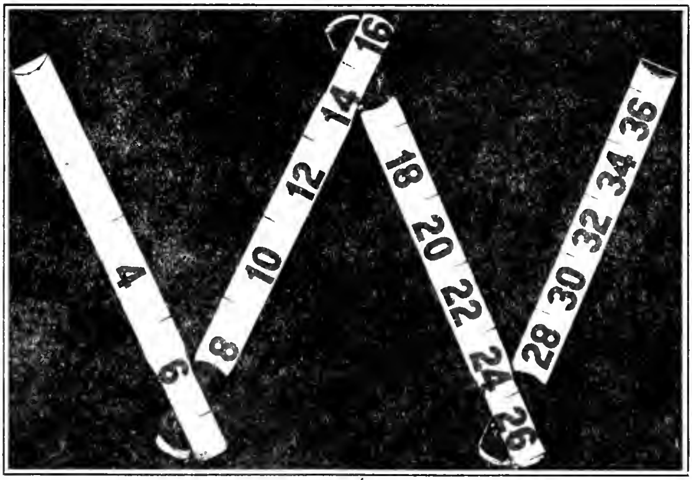
A FOLDING BILTMORE STICK

BY W. B. BARROWS

One disadvantage encountered in using calipers, especially large calipers, is that of transportation. They are clumsy things to carry around. A Biltmore stick is much handier, but the standard stick is rather long. In many cases a folding Biltmore stick will answer every purpose, and such a stick has the advantage of lightness and portability. The illustration below shows a folding stick made from a folding 2-foot rule. The figures on one side of the rule were scraped off with a piece of broken glass and small paper numerals were pasted on to



indicate diameters. The whole stick was then varnished two coats. If the figures are stamped into the wood with steel dies, blackened with a soft lead pencil and then varnished, they will remain legible even after long use. If no dies are at hand, the figures can be simply marked on in pencil and then varnished. The graduations between the figures differ from those ordinarily found on Biltmore sticks in that they represent odd diameters instead of even ones. Since every tree larger than 13 inches and smaller than 15 inches in diameter is tallied as a 14-inch tree when 2-inch diameter classes are used, it is obvious that it is more important to know whether a tree is a little over or a little under 13 or 15 inches than to know whether it is just under or just over an even diameter. The correct distances from the left end of the stick, at which graduations for odd diameters should be put, are as follows:

Figures to be Used in Graduating a Biltmore Stick

Diameter of tree, inches	Distance from eye to tree, inches				
	23	24	25	26	27
	Distance to be marked on stick, inches				
3	2.82	2.83	2.83	2.84	2.85
5	4.53	4.55	4.56	4.58	4.59
7	6.13	6.16	6.19	6.21	6.24
9	7.63	7.68	7.72	7.76	7.79
11	9.05	9.11	9.17	9.22	9.27
13	10.39	10.47	10.54	10.61	10.68
15	11.67	11.77	11.86	11.94	12.03
17	12.89	13.01	13.12	13.22	13.32
19	14.06	14.19	14.32	14.44	14.56
21	15.18	15.34	15.48	15.62	15.75
23	16.26	16.44	16.60	16.75	16.90
25	17.31	17.50	17.68	17.85	18.01
27	18.31	18.52	18.72	18.91	19.09
29	19.29	19.51	19.73	19.94	20.14
31	20.23	20.48	20.71	20.94	21.15
33	21.15	21.41	21.67	21.91	22.14
35	22.04	22.32	22.59	22.85	23.10
37	22.91	23.21	23.50	23.77	24.03
39	23.75	24.07	24.37	24.67	24.94
41	24.58	24.91	25.23	25.54	25.84
43	25.38	25.74	26.07	26.40	26.71
45	26.17	26.54	26.89	27.23	27.56
47	26.94	27.33	27.70	28.05	28.39
49	27.69	28.10	28.48	28.85	29.21
51	28.43	28.85	29.25	29.64	30.01
53	29.16	29.59	30.01	30.41	30.79
55	29.87	30.31	30.75	31.16	31.56
57	30.56	31.03	31.47	31.90	32.32
59	31.25	31.73	32.19	32.63	33.06
61	31.92	32.41	32.89	33.35	33.79
63	32.58	33.09	33.58	34.05	34.51
65	33.23	33.75	34.26	34.74	35.21

The reverse side of the stick can be used as a Merritt hypsometer by allowing 6 inches on the stick to each 16.3-foot log in the tree. If the arm length is 25 inches, the distance from eye to tree should be 67.9 feet. Similarly, for arm lengths of 23, 24, 26, and 27 inches, the distances from eye to tree should be 62.5, 65.2, 70.6, and 73.3 feet, respectively.

ANOTHER WORD ON SITE

By Filibert Roth

Professor of Forestry, University of Michigan

In the April number of the Journal Bates has a most stimulating article, "Concerning Site." It is not altogether clear whether the article is simply to discuss site classification or whether its chief function is to "draw fire." If the latter, it is a "winner," and in any case it is refreshing to see a real, live interest in a subject which so long has seemed to most of our American foresters as either of no value or else of such difficulty that it must be left to the far future, when all kinds of modern soil studies can be made.

The article starts out with the sentence: "The only final criterion of site quality is the current annual cubic-foot increment of a fully stocked stand of the species under consideration." It adds: "Any other criterion of site quality is a compromise or a makeshift, etc."; also: "In talking about the increment criterion of site quality, the writer is distinctly not discussing makeshifts or temporary expedients, but rather an actual standard of site qualities which *because it is exact* and contains the smallest possible element of human judgment *may now begin to be and remain forever the standard* of American foresters." . . .

Since yield tables, both European and American, claim that the current growth of a pure, even-aged stand is merely nominal in the first ten years, rapidly increases, reaches a maximum at 30 to 50 years, and then rapidly, later on more slowly, declines in its rate, it would seem that the same acre of land will be of low site quality at the start, be of the best quality when the growth is a maximum, and then decline as the stand grows older.

Bates seems convinced that the yield tables so far prepared are in error on this point. On page 386 a small table of figures from a lodgepole-pine study is to indicate that the current growth of a stand is a constant, and this is emphasized by a statement regarding hickory, which says: ". . . the increment was essentially the same over wide areas of uniform delta lands, *regardless of the age of the stand.*"

The table of lodgepole-pine figures is interesting and a part is here repeated. It is inferred that all figures are from a stand 55 years old, occupying a small piece of bench land, which *"showed no discernible difference in site quality."*

Plot number.	Number of trees per acre.	Current yearly growth per acre, cubic feet.	Basal area per acre, square feet.	Average d. b. h., inches.	Average height, feet.
4	8,902	49.5	154.0	1.78	20.4
7	941	81.7	112.6	4.68	40.0
9	305	56.5	82.5	7.07	41.1

The current growth here varies on a piece of land of the same quality by 60 per cent and does not impress one as being a *very "exact"* measure in this case. What the table does seem to tell rather clearly is the fact that crowding even in lodgepole pine (which can stand a good deal) reduces height growth (contrary to claims made on page 387); that it reduces volume growth, and that it is ruinous to quality growth, as shown by 1.78 inch average diameter of trees.

That this quality growth may also enter into the situation; that we are not in ordinary forestry practice concerned merely with pounds of organic matter as in a hay field, and that even the matter of dollars may be involved, is charily admitted. In the above case of lodgepole pine it may be that plot No. 9, with its 300 trees and only 56 cubic feet of current growth, may be the best stocked of the three.

Interesting in the table is the fact that plots 7 and 9, though differing more widely in stocking than would appear admissible in good forestry practice, present the same height growth (40 and 41 feet), and thus prove most conclusively that as long as a stand is not seriously overstocked (starved) the height growth does tell the truth regarding site, even though current volume growth may vary by over 40 per cent on the same area.

Bates claims very emphatically that height is not a proper measure of site, and that "height is *solely* controlled by the moisture of the soil," so that height is not competent to measure anything but the moisture factor of the site. But why is the spruce and fir on top of the mountains mere scrub, when often the moisture conditions of both air and soil are of the best? This "controlled solely" by moisture seems untenable, and the attempt to prove that crowding stimulates height growth, while an old story, seems disproven by the lodgepole-pine table, just as it is disproven by Mason's figures (*see* F. S. Bull. 154, pp. 7 ff).

The claim that sufficient study has been made of many of our forest trees, so that the current growth in volume is accurately known and may be used as measure of site, seems equally doubtful. With all due respect to the excellent work of Frothingham, Ashe, Mattoon, Sterrett, and others, it is doubtful if we have anything more than a fair estimate of growth of any tree excepting loblolly pine, and this only for its Eastern range. A glance at the recent bulletin on red spruce is interesting here. The growth of spruce on site I (p. 37) is given as follows: Diameter at 65 years, 10.2 inches; diameter at 100 years, 11.5 inches—a diameter growth of only 1.3 inches in 35 years. In another part it is stated (pp. 34 and 35) that it takes trees 10 inch and upward about 10 years to add an inch, so that the table should give at least 3.5 inches growth instead of 1.3 inches. And yet it is on this very spruce that much work and good work was done as much as twenty years ago. We are not even certain as to height and diameter of the individual tree, how much less as to volume growth per acre of the properly stocked stand.

In fact, it is not even approximately known what is the most suitable (normal) stocking for spruce for any given rotation or for any object of management (chiefly pulp as against logs), and we are fairly certain that the best number per acre for pulp would not be that for saw goods.

That site is classified with respect to species, of course, is old and might as well drop out of this study. The use of complicated classification, 1*a*, 1*b*, etc., might as well wait until there are more data; the starting with site I as the poorest land has been done abroad, and while merely a matter of language and agreement, does not seem to appeal to us. To call No. 1 land the poorest of all is contradictory to general usage in our every-day affairs.

The article forcefully brings up the question: What is it all for? There is no statement as to how the current yearly growth per acre might be used by a survey party, granted even that it might be of service. It admits that the matter of stocking is difficult to classify, as is indicated on page 385. "A 'fully stocked stand' may appear to be a vague thing." "The expression is, however, susceptible of *exact definition*, even if the determination of the condition of stocking is *next to impossible*." But the survey party needs a measure; the stand of wild woods (and the same applies in cared-for stands) is overstocked on one acre, understocked on another; the determination of the current growth of an acre of strip-survey is a difficult job and is never exact, in most cases a mere estimate; the age of the timber is generally not known, varies and is difficult to find for an entire acre.

And yet the survey should tell whether it is good or poor land for the particular species. To select a good tree, cut it down, and count the rings is simple and accurate far beyond most things we do in the forest. The fact that the height is remarkably independent of stocking is well shown by every study and by the figures in Bates' table. To sum up:

1. A measure is needed to enable a survey party to report intelligently on the quality of a piece of land for the growing of a particular kind of timber. This classification must remain simple to be of any use; Europe has not gone beyond five classes and we not beyond three.

2. In extreme cases high altitude, unduly steep or rocky ground, thin soil on rock, swamp, etc., the soil and situation practically tell the story. But in most cases a statement concerning soil, soil moisture, and the combination of various factors, including climate, which cannot possibly be known to any survey party; a general estimate of site, then, without the use of timber is too uncertain.

3. In using the timber, two ways have been proposed: (*a*) Volume of properly stocked stand (normal stocking) of given age (usually 100 years); (*b*) height of tree at given age.

The former method has been accepted as standard; the second method has never been accepted, and yet intentionally and unintentionally it has been used in connection with the former.

Thus, Schwappach depended on the height for his first site classification in selection of plots.

4. Even in cared-for stands the question of stocking has given a great deal of trouble and the conception of a normally stocked stand has changed, especially since 1850, and may change more. It varies often with the object of management. In the wild-woods work we begin before we know what a normal stand should be. We do know something concerning the growth of the individual tree; we know little as to growth of the stand.

5. The current yearly growth of an acre of strip survey cannot be determined accurately at all if the survey is to remain within practicable limits; the current yearly growth varies for the same stand with age and with seasons, and would make the same acre appear as belonging to different sites in different years; the current yearly growth in cubic feet depends on the stocking, and for overstocked stands ignores almost entirely the quality growth and may thus mislead in any attempt at classification.

6. Height and diameter make up a large part of quality and all of volume. Height, unlike diameter, is conspicuously independent of stocking, and consequently of treatment of forest. Height is easily and accurately determined, and thus makes a usable measure in survey work.

Height has been recognized for fifty years and more as the most convenient criterion of site, and recent studies abroad, though conducted in even-aged, pure stands, "man-made" and cared-for, have been obliged to use the height as the starting point, and have been unable to adhere to the accepted standard of volume (*see* Schwappach as against the standards of 1888).

Since we need a convenient, simple, and practicable site classification, and since this should preferably be quite uniform in principle to be useful, and since such classification needs general agreement, it is to be hoped that Bates' article may "draw fire" from many quarters.

HEIGHT GROWTH AS A KEY TO SITE[1]

By E. H. Frothingham

Forest Examiner, U. S. Forest Service

I think it is unnecessary to emphasize the peculiar importance in America of a standard rational classification of forest sites. Mr. Zon[2] has called it "our silvical mission" to perfect such a system—a result never yet achieved in any country. The mass of conflicting opinion and evidence published on "site" and "type" are sufficient proof both of the importance of the subject in the minds of foresters and of the perplexities which will have to be overcome before a practicable plan can be agreed upon. The writer's excuse for adding yet another paper on this subject is a study on which he and Mr. Russell Watson were engaged last summer in the southern Appalachians, which had for its object the beginning of classification of forest sites on the basis of height growth. Since this, so far as known, is the first actual field study which has been made toward this end, the ideas which have grown out of the field-work and a partial compilation of the results may be worth contributing.

A great deal of confusion can, it seems to me, be cleared away by showing clearly the difference in object between the two principal schemes of classification which have been suggested within recent years, namely, (1) that advanced by Mr. Zon,[3] the identification of the permanent forest types of the country and the determination of the physical factors responsible for them, and (2) Professor Roth's[4] proposal, amplified by Mr. Watson,[5] to classify all the tree species of the country according to the height attained at a specified age on the best sites, and to base site classes for each species on the degree by which the height falls off from this maximum, the height index of site being at arbitrarily chosen intervals. The important difference is that while Zon

[1] Presented at the annual meeting of the Society of American Foresters at Pittsburgh, January 1, 1918.

[2] Zon, Raphael: Quality Classes and Forest Types. Type Symposium in Proc. Soc. Amer. Foresters, VIII, 1, pp. 100-104, 1913.

[3] Zon, Raphael: Principles Determining Forest Types. Proc. Soc. Amer. Foresters, I, 3, pp. 179-189, 1906.

[4] Roth, Filibert: Concerning Site. Forestry Quarterly, XIV, 1, pp. 3-12, 1916.

[5] Watson, Russell: Site Determination, Classification, and Application. Jour. of Forestry, XV, 5, pp. 552-563, 1917.

would distinguish sites, once and for all, on the basis of the form of forest which will ultimately, under natural conditions, prevail. Roth would disregard this entirely, leaving the matter of site purely a function of the species which happened to be growing there. Zon's is a matter of the succession of forests, presupposing that the forester is interested mainly in the natural evolution of the stand; Roth speaks of site in terms of what it means for each and every species present, regardless of whether it is there to stay or only by sufferance.

It needs no argument to show that these are entirely independent ideas, conflicting in no respect, except perhaps in the order of precedence for immediate application. Even here there is really no dispute, for each is important and each is bound to receive attention. The object of this paper is not to argue one above the other as a necessary program, but to point out (1) what seem to be some of the limitations in regard to each; (2) why height growth as a site-indicator should be adopted generally by the profession, and (3) how the two plans can be made to fit in and lead to a fundamental and universal classification of American forest sites.

First, however, it is necessary to have in mind what qualities are desirable in such a scheme. In the writer's opinion, these may be briefly stated as follows:

(1) The plan should be fundamentally reliable for all future purposes of management, but yet simple enough to permit quick and reasonably accurate determinations in the field; in other words, it should be possible of immediate general use, subject to subsequent revision in detail.

(2) It should be universally applicable in principle, and yet adaptable enough for intensive use in small areas.

(3) While arbitrary lines must be drawn between site classes, these need not be the same for the entire country; standardization is more important in principle than in detail.

(4) The plan should provide a means of determining the site for all forests and forest land everywhere, and not be limited to pure, even-aged stands.

If these requisites are correctly stated, each plan of classification can be gauged by them.

Any method of determining forest sites must employ an indicator, whether this be the probable ultimate forest ("climax type"), the height growth of one or more species present, the current annual volume increment of a fully stocked pure stand, some herb or shrub typical of a locality, or merely the composition of the existing stand. Similar sites are then to be recognized either by the identification of similar indicators or by determining the similarity of the physical site factors. These may be measured in precise terms or simply estimated. Precise measurements appeal to the investigator. Accepting the permanent type as an indicator, for example, it would only remain to learn quantitatively the physical factors determining it. These physical factors, wherever found interacting in precisely the same amounts, will always produce in time, barring accident or design, precisely the same form of forest. The plan of a classification based on physical factors appeals to the investigator because it is truly fundamental. The apparent difficulties in deciding what is the permanent type in the isolation and measurement of the several physical factors, etc., may not be so formidable, after all, and the work may be simplified by the discovery that only one or two of the factors are of particular significance. But one is forced to conclude that we are far from a solution, except possibly in a few regions of simple forest distribution, and that the time is far off when we can adopt such a classification for the entire country. The problem is complicated by practical demands, such as the need of knowing promising sites for temporary as well as for permanent forms of forest. Since each temporary type has its own particular relation to site, not coincident with that of the permanent type, this, too, would logically demand a determination. The whole matter of the relative importance and the measurement of physical factors is still in the experimental stage and still subject to differences of expert opinion.[6] Much time will likely elapse and many revisions be necessary before a working agreement can be reached, and it is no argument against the study of physical factors to say that for the present we must get along without it, so far as a general classification of sites is concerned.

As a fundamental guide in silviculture, the value of a knowledge of the permanent forest type is beyond dispute, if only as a menace to be provided against. It would assure the forester as to the inevitable natural succession on a particular site and facilitate his choice of silvicultural methods to combat or to hasten the process. As a matter of fact, in many parts of the country foresters already know in a general way what to expect, although in the later stages of the succession, when two or more species are fighting for supremacy, the result may be difficult to foretell. In these later stages, too, the result may be easily con-

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[6] In his paper on Plant Formation and Forest Types (Proc. Soc. Amer. Foresters, IV, 1, pp. 50-63), Dr. Clements makes the following statement:

"From its nature, the building of such a foundation will be a slow and painstaking task, in which quantity of result and time must be almost completely ignored, and accuracy and permanence alone considered."

trolled and the forest maintained indefinitely by management in a state totally different from that which would ultimately prevail in nature.

In many large regions the permanent forest type is strikingly apparent. In other places it remains exceedingly obscure. Even where plainly evident, subdivisions with reference to yield are a necessity from considerations of future as well as present management.

This subdivision of permanent forest types or of any other kinds of types can be effected by the use of an indicator. Indicator plants, volume growth, and height growth are means to this end. Under certain circumstances the use of indicator plants may prove very useful, as experiments by Korstian[7] and others indicate. Objections which appear to invalidate it for general application, however, have been pointed out by Zon[8] in his review of Cajander's[9] work on this subject; since the indicator plants are not immune to the influence of biological factors of the forest, this method cannot be considered to have promise as a means of determining site except under special local conditions.

The use of the current annual increment[10] as a means of determining site involves the double difficulty of securing a basis and of applying the measure of the site, when found, to the identification of similar site conditions elsewhere. As an exact indicator it may prove the last word in refining previous site determinations in localities where it can be employed, but as a general method, suitable for immediate use, it fails to meet the requirements of simplicity and wide-spread utility previously set forth.

The utility of height—one of the functions of volume, but far less unwieldy as an index—ought to be plainly evident to every one as the logical immediate basis for subdivision. Height growth, as a matter of fact, appeals in two ways: First, as an immediate means of classifying forest sites in general, and, second, as a guide and a short cut in arriving at a possible future classification of sites on a physical or permanent type basis. There are a number of objections to the use of height

[7] Korstian, Clarence F.: The Indicator Significance of Native Vegetation in the Determination of Forest Sites. Plant World, vol. 20, No. 9, pp. 267-287, 1917.

[8] Zon, Raphael: Review of Prof. A. K. Cajander's Ueber Waldtypen. Proc. Soc. Amer. Foresters, IX, pp. 119-125, 1914.

[9] Cajander, A. K.: Ueber Waldtypen. Fennia 28, No. 2, 175 pp. Helsingfors, 1909.

[10] Suggested by C. G. Bates in the following resolution, introduced at the meeting of Forest Investigators, Washington, D. C., March 1, 1917 (p. 304 of the Proceedings of the Meeting):

"*Resolved*, That the only final criterion of site quality is the current annual increment of the species concerned as judged by the measurement of a stand approximately fully stocked."

growth as a site-index, however, which must be met. While not insurmountable, they point to precautions and modifications in the simple height-growth classification which must be accepted if the method is to receive serious consideration. The most important of the objections are: (1) That height growth is too sensitive to incidents in the history of the stand, such as origin (sprout or seed), changes in density, and interferences in the normal growth of the stand, such as culling, fire, grazing, etc.; (2) that the mere determination of site on the basis of height growth tells nothing about the factors which produced it, nor what the same site would produce if other species are grown, nor whether even the same species would grow equally in height on the same site a second time under the same or a different kind of treatment,[11] and (3) that a given species may exhibit the same height growth on widely different sites, as in swamps and on dry uplands.

With respect, first, to the infinite possibilities in the history of the stand which may affect height growth, we must admit the justice of this objection, at least in so far as it concerns the ultimate, precise classification of local sites which it is probable the future will bring. As to the larger determinations in the wild woods, culled or virgin, it is necessary to assume, until the contrary is proved, that the effect on height growth of the physical factors is far more potent than the effects of all interfering agencies which are not so plain to the eye that they would be discounted or excluded as a matter of course. There is a certain consistency in the variation both in crown height and merchantable length[12] of our native forests, in spite of their checkered careers. In the mature forest, therefore, the height growth having practically ceased, the average total height of dominant trees of each species can be quite safely regarded as reflecting the relative possibilities of the site. This has been pointed out by Roth.[13] In the juvenile stage height growth would certainly be misleading, as it is known to be more or less independent of site.[14] Between these two extremes the effects on height growth of past changes in density, of fire, etc., must be avoided by careful choice of specimens for measurement—healthy trees which have always been dominant.

[11] These points are discussed by Schiffel (Ueber Bestandeserzichung. Cent. f. d. g. Forstwesen, Aug.-Oct., 1906, pp. 333-5, 405-425. Reviewed in For. Quart., IV, 4, pp. 326-336) and Vater (Ueber die Anstellung waldbaulicher Versuche und ueber die Klassen der forstlichen Ertragstafeln. Tharandter forstliches Jahrbuch, 1912, pp. 252-264. Reviewed in For. Quart., XIII, 3, pp. 391-4).

[12] Merchantable length is, in fact, the present basis of site distinction used by the Forest Service in the Southern Appalachians.

[13] *Op. cit.*

[14] Mayr, Heinrich: Waldbau, p. 132, 1909.

The second objection—that the mere determination of site by height growth tells nothing about the physical factors—is unessential, since it applies equally to all site indicators. The physical environment should always be described in all possible detail; otherwise the classification becomes a mere catalogue of heights with little practicable value. The omission of such data from many of our published yield tables was unfortunate. It is generally recognized that differences in the physical factors of site are often hard to describe and exceedingly hard to formulate as bases for a site classification. This is for the forest experiment stations to work out. In the meantime and for many years to come we must be content with less refined determinations.

The third objection—that a given species may show the same height growth on different sites—is undoubtedly valid as a fact, and it appears to necessitate a modification of the numeral classification of sites based on height growth. A great number of our species recede from optimum growth conditions in the direction of poor soil drainage on the one hand and excessive drainage on the other. In either direction points may be found where the height growth is the same, yet the site conditions, the yield, and the indicated management are totally different. Here it seems that the height-growth basis must point to its other virtues and acknowledge its inability to cope logically with the situation. A simple mechanical way out of the difficulty is to supplement the site class number with a word designating the physical cause for less than maximum height, or "spruce, site IV (swamp)." It would be unnecessary to qualify both directions of deviation from the maximum. It should be noted that just such a procedure is essential in species studies, whether or not a standard classification of sites based on height growth is adopted.

Professor Roth's "blanket" schedule of "standards" subdivided into "sites" and inclusive of all important North American species is exceedingly restful to the eye. It may be that it has cut the Gordian knot which Mr. Zon insists should be untied. Undoubtedly there are yet difficulties to be overcome before its full object can be attained. For example, it is doubtful whether we can resist the temptation to deflect it from its true purpose by impressing the height growth of certain index species—like chestnut in the East—to determine a large class of forest sites irrespective of, or at least superior to, other species present. Then there is the possibility that the total height attained at maturity will prove a better basis at first than that at 100 years or any other designated age. In view of the great difference between species in the progress of height growth, the age-height curve would seem the most natural basis of all for comparing the growth of different species on the same site, as well as for identifying sites containing trees of the same species but of different ages.

In conclusion, the principle of height growth as a guide to site has the following features:

1. It is simple, natural, easily understood, and easily applied in the field.

2. It is independent of the determination of physical sites producing definite permanent forms of forest; but the two are not antagonistic; both are "indicators" and both demand equally a determination, more or less refined, of the physical factors of site.

3. The sites determined by height growth are species sites, not permanent type sites; hence they are useful with reference to short-lived intolerant and to long-lived tolerant species growing in the same stand.

4. By adopting one or more index species (intolerant species of wide occurrence on a variety of sites) the height growth of other species can be gauged, their relative value in each site can be determined, and this value can be expressed by naming the site in terms of the growth of each species present and by analogy of other species which do not happen to be present.

5. It affords a means of comparing the growth of all American species on the basis of the soil and climate to which each is best suited, as well as in less favorable sites.

6. It permits a ready comparison (*a*) between even-aged second-growth stands in widely different regions, thereby avoiding such inconsistencies as those to be found in the published yield tables for the same species in different states, and (*b*) between second-growth and old-growth stands in the same or different regions.

7. Since height growth is sensitive to interferences in the natural life of the stand (fire, culling, changes in density, etc.), care and judgment are necessary in the choice of trees to serve as the index; but, except for very precise site determinations, the method, if used with ordinary caution, will undoubtedly prove serviceable for the majority of wild-woods conditions as well as for even-aged stands.

8. As the knowledge of the laws of growth of our species increases, the refinement of site determination by height growth can be increased.

Finally, if it accomplishes nothing else than to stimulate our efforts to learn the progress of growth of our species and the laws determining it, their proposed system of classification will have served a great purpose. Its greatest possibilities lie, however, in the direction of a workable classification within a reasonable time.

NURSERY PRACTICE IN PENNSYLVANIA

By George A. Retan

At the beginning of the planting season of 1918 there was in the Pennsylvania nurseries available stock for use of about 12,000,000 forest-tree seedlings. A comparative statement shows that this represents a considerable increase over that of past years. In the last four years the seedlings shipped from these nurseries had totaled as follows: 1914, 3,229,000; 1915, 4,465,000; 1916, 5,445,000; 1917, 5,345,000.

The large advance in reforestation which this production has made possible has resulted in the accumulation of experience which has been very inadequately presented to the profession. Recent publications have dealt fully and interestingly with the work of the Forest Service and the general practice. It is not the purpose of this article to deal at length with the operations more or less similarly conducted in all nurseries, but rather to detail such work as represents a departure from the commonly recognized routine.

No doubt much that is peculiar to the nursery practice in this State is a result of an aim which departs widely from that of the average nursery. This is, briefly, the production of two and three year seedlings rather than transplants. Experience in most divergent growth and climatic conditions on areas totaling over 10,000 acres has led to the conclusion that the healthy, symmetrically developed seedling will give as good results as the much more expensive transplant. The only exception is that Norway spruce has occasionally to develop with sufficient rapidity under adverse conditions. In one case the writer urged the use of one-year white-pine seedlings; this was very successful, and there is no reason to doubt the practicability of the use of one-year white pine from fall-sown beds on cleared or partially cleared sites.

The seedlings shipped are quite a different product than that of the transplant nursery with its densely crowded seedling beds. It is found that a density averaging from 70 to 100 seedlings to the square foot allows of a symmetrical development of root, stem, and crown and assures the greatest success. A density of over 70 to the square foot leads to a decrease in the weight of the seedlings. While it is more expensive to raise such seedlings, they are much cheaper than transplants. Typical costs from Mont Alto records are as follows:

	Per thousand
Scotch pine, 2/0, 56 to square foot	$0.99
White pine, 3/0, 60–90 to square foot	1.66
Pitch pine, 2/0, 80 to square foot	.89
White pine, 2/0, 70 to square foot	1.06
Norway spruce, 2/0, 35 to square foot	1.65

Using 900 to 1,200 of such seedlings per acre, the total plantation cost varies from $3.53 to $9.22 per acre. In 1916 the average cost per acre of all State plantations was $6.10.

Four large and 22 small nurseries are maintained on the State Forests. The tendency is toward the concentration of production in the larger nurseries because of the economies made possible in large-scale production. Where peculiar site conditions make the large nursery advisable, such nurseries will be maintained. Examples of such nurseries are the Cross Fork and Pump Station nurseries. The first is valuable for educational purposes and because of its remoteness, saving transportation; and the second because of its utilization of labor and nearness to large planting cleared areas. Of the annual production less than 7 per cent is grown in the small nurseries.

The sites of the four larger nurseries are typical of as many different growth conditions. The Asaph Nursery is in a narrow valley in the glacial section of the north tier. Climatic conditions are most severe. Killing frosts have occurred in every month and the growing season is normally very short. Soil conditions are very variable throughout the nursery, as the soil is largely wash. The Clearfield Nursery is on the plateau, with a northern exposure, at an elevation of 2,200 feet. The soil is a loamy sand with an acid reaction. The nursery is subject to strong west and northwest winds. The Greenwood Nursery is situated on the northern slope of one of the central Pennsylvania mountains at an elevation of 1,200 feet. The soil has been formed through the disintegration of the Clinton shale and is very shallow. The Mont Alto Nursery is situated at the western base of one of the South mountains at an elevation of 900 feet. The soil is a heavy clay. It follows, naturally, that methods differ considerably under the diverse conditions and that generalizations are hard to make.

Little coniferous seed is gathered in the State. Most of the hardwood seed used is gathered by the State Foresters in the locality where it is most abundant. Native white pine is gathered when possible. Undoubtedly too little attention is paid to the source of our seed of European species. Especially is this true since the war began. It has been impossible to learn anything about such seed. It is very probable, judging from the germination tests, that such seed represents left-overs in the hands of various American and French dealers. All the seed bought is carefully tested by the Silvicultural Department at the Forest Academy. Either the Steiner Keimplätte, or a dirt test, or both, are used. The latter is much more accurate for nursery work and shows an error of 10 per cent or less. The former is more valuable as testing the freshness and general viability by observation of the germinative force.

The writer has found that one of the most commonly neglected, but essential, conditions of economical work is the careful subdivision of the nursery. In the Mont Alto Nursery there are about 1,200 beds of 100 square feet each. Of these about 400 are sown each year. This number of beds requires 2,000 screens and 5,600 stakes. To move these any considerable distance is a time-consuming and expensive operation. To reduce such work to the minimum, the nursery is divided into three working sections. Each working section contains three units. One unit of each working section is to contain one-year-old stock, one two-year-old stock, and the third a soiling crop. Screens and stakes are placed in a reserved space central to the working section. The short 25-foot bed is preferred by two nurseries; a bed about twice as long is used in the others. At Mont Alto I am using alternate two and five foot paths to save transportation costs. Three-foot aisles are used in the other nurseries. Eighteen-inch paths are used in all.

In the Mont Alto Nursery fall sowing predominates; in the others spring sowing. Up to this time only red and white pine have been fall-sown here. Two-year seedlings from fall-sown beds are nearly equal to average three-year-olds. The quantity of seed necessary is greatly reduced in fall sowing. Sixteen ounces of average white-pine seed is rather too heavy for 100 square feet. Six ounces of red pine is sufficient. There is no loss from damping-off in fall-sown beds; the only serious loss is from birds in spring after germination starts. A small army of boys is necessary to keep the birds off the beds.

In the Greenwood Nursery the beds are thrown up by the plow and then raked down. At Mont Alto the ground is carefully harrowed and worked and shallow paths made by spading. The depth of the path in the different nurseries depends on the soil and the drainage. Heavy soil demands a deeper path; also deeper paths are needed where surface drainage is the rule.

After sowing at Mont Alto the soil is covered by a mixture of sand and compost; at Greenwood by a mixture of compost and charcoal screenings. Both methods give admirable results and eliminate caking. Pine needles are, in general, favored for covering the bed. They lie better and seem to lead to better germination, possibly due to their dark color. At Mont Alto the bed is finally covered by a four-foot "tobacco bundle paper." This paper comes in 250-pound rolls and costs, laid on, about 13 cents per bed. It must be covered by screens and weights. It can be used the second winter if handled carefully, thus reducing the cost. This paper prevents any trouble from birds during the winter until germination is well under way. This is much cheaper than the Pettis screen. (The paper is, of course, much dearer at present.)

A considerable item of expense in some nurseries is due to the hoeing of the paths. The Greenwood Nursery first, and later others are using the one-horse cultivator or scraper. Forester Bietsch, at Greenwood, is also trying the sowing of cowpeas in the paths of two and three year seedlings. Weeds are thus eliminated and nitrogen is added to the soil.

The Pennsylvania nurseries have taken an advanced position in methods of watering. The Clearfield and Greenwood nurseries have a permanent form of the "Skinner System" over their whole area. At Mont Alto a permanent form was tried, but was found objectionable in some respects. A temporary form was worked out by the writer, which, with much less expense, is very satisfactory. Sections are laid out, so that 100 feet of line is the average requirement in the three-foot aisle. Temporary surface lines are laid out, with standpipes at the head of the three-foot aisles of the section. Stakes about four feet high are placed in the aisles. The temporary line is moved from aisle to aisle as desired and quickly attached to the standpipe. One 100-foot length can supply from 80 to 120 beds very satisfactorily. After the first summer the temporary lines are all removed and there is nothing in the road to hinder cultivation. With the Skinner System there is a great temptation to water too heavily and force growth. Careful supervision must avoid this. In the second and third years irrigation in the paths is preferred to sprinkling.

Screens seem necessary in Pennsylvania nurseries for about six weeks. In the fall-sown beds there is less need. Some beds were tried without screens last year and look good. Fall-sown seed germinates about May 1, and the seedlings are out of danger from sun scald by June 1, if watered occasionally.

Of the common nursery troubles, "damping-off" has been the only one to cause any considerable trouble. At Clearfield it is almost unknown. At Greenwood it is combated by management of screens and the method of seed-covering mentioned above. At Mont Alto fall sowing eliminates it for the beds sown at that time. The method of seed-covering and careful drainage keeps it under control in spring-sown beds. Acting on a hint from Professor Coville, the writer has been experimenting with a natural acid treatment. It is noted that Clearfield and Pump Station have little "damping-off" and that their soils test acid. It was assumed that a natural acid condition would stop the trouble. For two years acid soil was brought into the nursery and used in comparative work. This last year not only was this done, but also acid leachings from leaves were applied to ordinary nursery beds. Unfortunately, owing to the departure of the senior carrying on the work, only incomplete data are available for the latter portion of the experiment. Results so far secured are as follows:

Year	Species	Per cent of survival	
		Acid	Check
1915	White pine	80.7	..
1916	Spruce	83.5	56
	Pitch pine	92	62
	White pine	78	30
1917	Spruce	70	42
	Spruce watered with acid leachings	79	72 *a*

a Not complete.

As a result of these experiments it is recommended that no lime be used in the Mont Alto Nursery, and that raw humus be used as a fertilizer to some extent.

Much experimentation with various fertilizers has been done in the past few years in some of the nurseries. The general results were published in the 1914-1915 Report of the Pennsylvania Department of Forestry. At Mont Alto a careful effort was made to analyze these results carefully and to follow out some suggested leads. The original experiment called for a test of seven chemical fertilizers, lime, and stable manure in many different combinations. Altogether 28 beds of single and double applications were used. Each bed had a surface area of 100 square feet. Single applications gave the following actual plant food: .75 pound actual N; 1 pound P_2O_5; 1 pound $k''O$; 1 pound CaO. To secure these the following fertilizers were used: Nitrate of soda, sulphate of ammonia, dried blood, acid phosphate, bone meal, floats, sulphate of potash, pure hydrated lime, burnt lime. A tabulation of the combinations and the results follows:

Combination	Weight of average 100 seedlings	Departure from check average	
1. Sodium nitrate	182	—19	
2. Sodium nitrate + acid phosphate	205	+ 4	
3. Acid phosphate	183	—18	
4. Acid phosphate + potassium sulphate	183	—18	
5. Potassium sulphate	210	+ 9	
6. Potassium sulphate + sodium nitrate	274	+73	
7. Potassium sulphate + acid phosphate + sodium nitrate	268	+67	
8. Ammonium sulphate + potassium sulphate + acid phosphate	269	+68	
9. Ammonium sulphate + potassium sulphate	252	+51	
10. Ammonium sulphate + acid phosphate	240	+39	
11. Acid phosphate + dried blood	224	+23	
12. Potassium sulphate + bone meal	238	+37	
13. Bone meal + dried blood	196	— 5	
		——	+25

Second tier, single applications

14. Bone meal	127	—18	
15. Potassium sulphate + bone meal + dried blood	157	+12	
16. Dried blood + "floats"	157	+12	
17. "Floats"	140	—15	
18. Ammonium sulphate	157	+12	
19. Dried blood + lime	134	—11	
20. Lime	136	— 9	
		——	— 1

Third series, second tier, double applications

1.	176	—11	
2.	238	+51	
3.	188	+ 1	
4.	210	+23	
5.	216	+29	
6.	248	+61	
7.	218	+31	
8.	261	+74	
9.	255	+68	
		——	+36

Fourth series, third tier, double application

10.	222	+66	
11.	117	—39	
12.	180	+14	
13.	153	— 3	
14.	105	—51	
15.	150	+ 5	
16.	129	—25	
17.	127	—29	
18.	154	— 2	
19.	158	+ 2	
20.	215	+41	
		——	— 0

NOTE.—Every fifth bed was a check.

These combinations were applied at the time of sowing and raking, except that the nitrogen fertilizers were applied as a top dressing after the seedlings had thrown off the seed coats and the application repeated in four weeks to complete the full amount. The top dressing proved disastrous and the beds so treated were uniformly very poor and thin. When two years of age, the seedlings were lifted, all loose dirt shaken off, and weighed. From the total weight of all the seedlings in the bed the weight of the average 100 bundles was obtained. Only eight beds had less than 1,000 seedlings; some had over 5,000; altogether over 130,000 seedlings were weighed.

The figures given are meaningless without the following explanation: The first 18 beds are in the first tier; the following 10 of the single application and the first 12 of the double application are in the adjoining tier, and the remainder are in the third tier. The soil is a clay loam and became rapidly poorer and heavier from the first to the third tier. The weight of the average check and average fertilizer bundle in each group was taken as a basis of comparison. Minus and plus signs refer to the weight departures from the average check of the group. Thus where + precedes a number it indicates that the bundle exceeded the average check of that particular group by the number given. These + marks are almost invariably connected with fertilizers containing ammonium sulphate or potassium sulphate.

Nearly 7,000 seedlings from beds adjacent to the last group of fertilizer beds, where equally poor soil had been treated with charcoal, showed a weight of 250 grams per 100, or a departure of +94 over the adjacent group of fertilized beds, and a considerable increase over all groups, and over all but a very few individual beds.

The beds treated with P_2O_5 were the most densely stocked and appeared better than the checks, even though the weights do not show any marked difference. It is possible that density of stocking may have influenced the weights in this case. Beds so treated suffered least from "damping-off." In 1914 a second series of only 10 beds was run to verify results, and + departures are again shown only for combinations containing ammonium sulphate. The general results were too disappointing to justify the use of fertilizers in the Mont Alto Nursery. Green manure and charcoal have given much more desirable stands and better seedlings.

In lifting seedlings no improvements have been tried. Potato forks are commonly used. In shipping, wooden boxes and crates are used in large shipments. For small shipments fiber cartons are used. These come in three sizes and cost about 7, 11, and 25 cents each. An insulating paper is used inside to prevent the damp moss softening the carton. Packing, including moss, labor, and twine, costs from 10 to 20 cents each. Weights when completely packed run from 7 to 60 pounds. These are all sent by parcel post.

One feature is emphasized in Pennsylvania nurseries much more than in most State or commercial work: the system of records and accounts. In an endeavor to definitely determine the cost of raising various species and to secure accurate records of each operation, each purchase of seed is kept as a unit throughout its nursery treatment. This is made possible by two simple and convenient forms. These were first recommended by the writer after a trial at Mont Alto, and were afterwards revised by W. Gardiner Conklin, of the Department, in consultation with all the nurserymen of the State. Each day's work of distinctive character is summarized on Form 67, work on each unit being kept separately. Only 11 classes of work are recognized on Form 68, to which the monthly total of all day sheets dealing with that unit is posted. The Form 68 then gives a complete record of the unit from the time of its separation. Overhead expenses are recorded in a journal and prorated per bed at the end of the year. The following charges are recognized as overhead: Administration, water-system upkeep, compost, screens, maintenance of grounds, experimentation, interest on the capital items of land, buildings, and depreciation on tools, water system, drains, etc. In the Mont Alto Nursery these overhead items total approximately $1,000 of total charges of $2,500 to $3,000. Of this amount $500 is the annual administration charge. The influence of these charges on seedling costs are not generally recognized. It is a careful study of this fact that has led to such a determined effort on the part of the writer to effect economies in management. In the Greenwood Nursery, for instance, overhead charges for the water-system depreciation alone are $250 on an output of one and one-half million seedlings, or about 16 cents per thousand. As typical of the results this system has given, some costs are appended, each an average of many units:

	Per bed *Cents*	Per M *Cents*
Lifting, counting, and heeling in two-year seedlings	.....	15
Packing (excepting container cost)	.....	6.5
Protection of one-year beds for the season	17–21	....
Weeding one-year beds for season	29–99	....
Cleaning paths of one-year beds for season	6–8	....
Weeding two-year beds per season	9–34	....
Cleaning paths of two-year beds per season	12–16	....

We print in this connection the carefully worked out schedule of report of the nurseries of the Pennsylvania Department of Forestry:

FORM No. [illegible]

PENNSYLVANIA DEPARTMENT OF FORESTRY

SEED BED RECORD ______________________ NURSERY ______________________ FORESTER

Species ______________ Area of Beds ______________ Sq Ft   Years 19____, 19____, 19____

Section ______________ Tier ______________ Beds ______________ Tier ______________ Beds ______________

Section ______________ Tier ______________ Beds ______________ Tier ______________ Beds ______________

SEED. Source ______________________________ (Locality obtained) Purity ________ % (Clean seed)

Number per lb ______________ Amount per 100 sq ft ______________ oz or bu   Total Amount Used ______________ (lbs & oz. or bu.)

Cost per ______________ (Unit of measure) $ ______________ Method of Sowing ______________ (Broadcast, drills, furrows)

Germination Inside Test ______________ % in ______________ Days   Nursery ______________ % in ______________ Days

Description of Germination ______________________________ (in beds—Slow, rapid, even, uneven etc)

FERTILIZING Kind and Quantity ______________________________ (Of Fertilizer)

Soil Condition and Description of Treatment ______________________________ (At time of sowing)

____

Cost of Fertilizer $ ______________ Application $ ______________ Date of Application ______________

Results ____

GENERAL PREPARATION			BED MAKING		SOWING AND MULCHING		LOSS	
(1) Month	(2) Character of Work	(3) Cost	(4) Date	(5) Cost	(6) Date	(7) Bed Nos	(8) Date	(9) Cause

PROTECTION		WEEDING & CULTIVATION		PATHS		WATERING		WINTER COVERING		
(10) Month	(11) Cost	(12) Month	(13) Cost	(14) Month	(15) Cost	(16) Month	(17) Cost	(18) Date	(19) Material	(20) Cost

INVENTORIES		
(21) Date	(22) Estimated Number	(23) Cost

LIFTING AND BUNCHING		
(24) Date	(25) Number	(26) Cost

SUMMARY OF COSTS BY YEARS			
Accounts	(27) 19	19	19
Seed			
Fertilizing			
Gen. Preparation			
Bed making			
Protection			
Weeding and Cultivation			
Paths			
Watering			
Winter Covering			
Inventories			
Lifting and Bunching			
Pro Rata Accounts			
Total			

FINAL COST OF PLANTS   TOTAL $ ______________ PER M $ ______________

REMARKS

PRIVATE PLANTING IN PENNSYLVANIA

By N. R. McNaughton

In Charge of Bureau of Silviculture, Pennsylvania Department of Forestry

Forestry has come to stay in Pennsylvania. The best evidence of the truth of this assertion is contained in the table on the next page.

In studying these figures it should be remembered that the number planted of each species cannot always be accepted as an index of the planters' wishes. The Department may dispose of seedlings to private planters only when the stock in its nurseries is in excess of the needs of the State forests. This accounts for the fact that 50 per cent of the seedlings were white pine, for the Pennsylvania nurseries have had an excess of white pine for several years past. It is interesting to note that since the blister-rust scare of 1916 the number of white pine shows a steady decrease, although the total number planted shows a decided increase. The species used in smaller numbers, such as the larches, red pine, and the hardwoods, are seldom available for distribution except in limited quantities.

From 1910 to 1915, inclusive, the seedlings were sold at the cost of production. After 1915 no charge was made for the seedlings, and applicants were asked to pay only the cost of packing and shipping. This fact accounts for the large increase in planting during and after 1916.

That the public is definitely enlisted in this work is best shown by the figures for 1918. In spite of serious labor shortage and press of other work, the figures show a substantial increase over 1917, when better and cheaper labor was available. The total number of applicants for seedlings in 1918 was about 600. The largest single application was from a water company for 170,000 seedlings. The second largest application was from the city of Altoona for use on the municipal watershed. One other city, several boroughs, a dozen water companies, a steel company, and several coal companies were among the applicants. The minimum number granted to an applicant was 500, and the average application called for about 3,600.

Private Planting in Pennsylvania

Stock Furnished by the Pennsylvania Department of Forestry

CONIFERS

Year	White pine	Scotch pine	Red pine	Pitch pine	Norway spruce	European larch	Japanese larch	Douglas fir	Total conifers
1910	44,500	.....	.....	.....	10,000	.....	.....	....	54,450
1911	16,290	121	.....	.....	4,265	915	.....	10	21,601
1912	25,850	300	.....	.....	12,100	200	.....	....	38,450
1913	18,962	437	5,300	325	12,750	930	.....	10	38,714
1914	87,580	1,950	3,515	.....	3,555	500	.....	1,410	98,510
1915	63,035	2,820	16,781	524	21,935	3,239	.....	3,750	112,084
1916	1,011,310	147,210	.....	41,535	116,090	11,430	.....	....	1,327,575
1917	977,725	356,300	13	83,400	116,300	146,055	25,700	2,950	1,708,443
1918	702,500	360,875	182,025	137,250	445,265	189,472	13,050	200	2,030,637
Totals	2,947,702	870,013	207,634	263,034	742,260	352,741	38,750	5,330	5,430,464

HARDWOODS

Year	White ash	Black walnut	Maple sugar	Red oak	Honey locust	Black cherry	Mixed hardwoods	Cuttings	Total hardwoods	Grand total
1910	2,100	1,555	2,274	1,600	50	25	970	3,350	11,924	63,374
1911	318	1,250	200	310	200	260	721	500	3,759	25,360
1912	1,204	....	200	25,000	2,000	....	....	.....	28,404	66,854
1913	2,766	540	1,750	75	2,800	100	150	875	9,056	47,770
1914	.....	1,625	250	....	1,200	500	1,350	5,250	10,175	108,685
1915	30	....	150	2,531	300	406	76	.....	3,493	115,577
1916	52,460	....	33,200	....	35,190	3,950	1,900	17,600	144,300	1,471,875
1917	14,200	....	15,100	....	1,650	....	4	73,600	104,554	1,812,997
1918	68,712	....	4,050	7,050	3,600	2,100	7,825	57,625	150,962	2,181,599
Totals	141,790	4,970	57,174	36,566	46,990	7,341	12,996	158,800	466,627	5,897,091

SOME NEW ASPECTS REGARDING THE USE OF THE FOREST SERVICE STANDARD (GRADIMETER) HYPSOMETER

By Hermann Krauch

Forest Examiner, U. S. Forest Service

While engaged at the remeasurement of sample plots in the fall of 1916, the writer found that the new measurements of tree heights were in many instances lower than those secured five years previously. An attempt was therefore made to determine the reason for these discrepancies. The source of error was at first ascribed to the fact that different types of hypsometers were used during the respective periods of measurement. The same deduction has also been made by other investigators.[1]

The use of incorrect horizontal distances in taking readings (especially where steep slopes are involved) was also thought to be a factor. But careful investigation indicated that the condition which is most apt to cause discrepancy between two sets of readings is the variance of trees from a vertical position.[2] In other words, readings taken from different points are not the same for the reason that horizontal distances (top of tree considered) are different. The following diagram (figure 1) will make this point clear.

While the readings from points A and B may have both been taken at distances measured along a horizontal line exactly 100 feet from the *base* of the tree, the distances actually involved, in so far as the use of the hypsometer is concerned, are different, being 104 feet and 96 feet, respectively.

The degree of discrepancy between readings taken from different points, moreover, increases in direct proportion with the increase in heights of trees measured. Two factors affect this:

1. A proportional increase in horizontal distances, considering that these distances are measured from the base of the tree, whereas the position of the top is actually involved.

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[1] See article—"Comparative Test of Klaussner and Forest Service Standard Hypsometers"—Douglas K. Noyes, October (1916) Proceedings.

[2] This was tested repeatedly by taking readings of trees from different directions. Wherever great discrepancies occurred it was found that the trees were not standing vertical. This condition is not readily perceived without the use of a plumb-line, but the fact is that there are few trees which stand absolutely vertical.

2. An increase in the degree of error as recorded in reading the hypsometer. The latter condition is true because the Forest Service Standard Hypsometer reads in percents, and therefore the higher the tree the greater the degree of error recorded on account of incorrect horizontal distance.

Since it appears essential that the same points from which the original readings of trees were taken be relocated in making subsequent measurements, attention is called to the following facts concerning the use of the Forest Service Standard Hypsometer. By using the following method, relocation of points is easily accomplished and the chances for error due to conditions, as noted, are largely eliminated. While

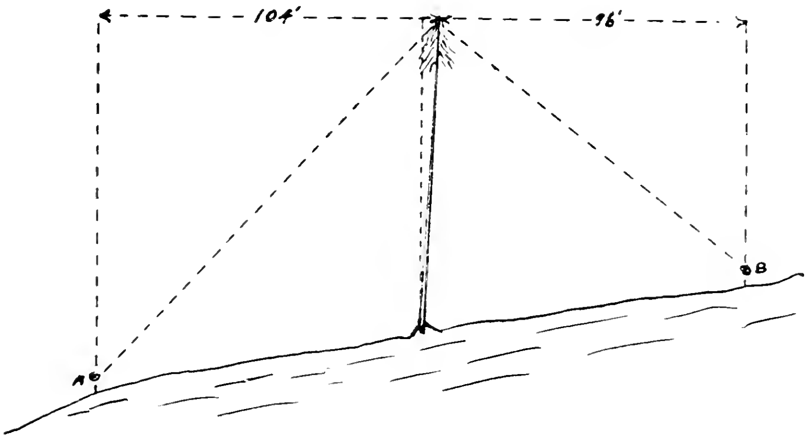

FIG. 1

absolute heights may not always be obtained, accurate record of *increase* in growth will, however, be secured.

The essential principle involved in the new method is, that instead of it being necessary to stand exactly 100 feet, or multiple distances thereof, away from the tree, any distance from which a good sight can be secured may be used. Additional computation is, however, necessary in order to obtain the correct heights, but this can be done in the office after the field data have been secured. Since any distance can be used for taking readings, several tree heights can be read from the same point, and the relocation of this point is therefore readily accomplished when subsequent height measurements are to be made.

The following example clearly illustrates the method of obtaining data:

Horizontal distances, feet	Instrument readings, feet	Height of tree, feet
120	60 +5 65	78

The height of the tree is obtained by merely adding the instrument readings and multiplying by the horizontal distance (120 feet) used and then pointing off two decimal places. In other words, the relationship between the reading on the hypsometer scale and the horizontal distance used is constant—that is, the product is always the same. Hence, when the product is divided by 100 the true height of the object measured is obtained.

In view of this relationship it is not necessary to make allowance for slope at the time field data for tree heights are taken. Following is an example:

Distance of observer from tree (measured along slope), feet	Horizontal distance, feet	Instrument readings, feet	Height of tree, feet
100	98	90 —15 75	73.5

The height of the tree is computed as follows: First determine the *horizontal* distance, which is derived from the geometrical relationship of the hypotenuse (distance measured along slope) to the side of the right triangle (distance from base of tree to zero point recorded on hypsometer scale, plus 5 feet).[3] In the example cited the side of the right triangle is 15 feet + 5 feet = 20 feet and the base is therefore 98 feet. (See figure 2.)

In making computations to determine the relationship between side and base of the right triangles, a table can be previously prepared for convenience. Having secured the correct horizontal distance, the true height of the tree is determined as described under the first example cited.

Since readings with the Forest Service Standard Hypsometer can be taken at any distance (within the limits indicated by the instrument's scale) its practical value is also enhanced. This applies especially in the case of dense stands, where it is often difficult to locate a point exactly 100 feet (or multiples thereof) distant from the tree and at the same time be able to see the top. Furthermore, since several read-

[3] Five feet are added to the minus quantity because distances are measured between position of observer's eye and same point (5 feet) above base of tree. In the case of plus distances (indicating that readings were taken *up* slope from base of tree) the 5 feet factor is subtracted.

ings can be taken from the same point by merely measuring the distance to each tree, greater speed in securing field data is possible than where a new point must be chosen for each tree.[1] The relocation of a point common to several trees is readily made in subsequent readings if the distance and bearing to only two trees is known.

The method described may be considered objectionable on the score that true height readings cannot be secured directly in the field without considerable extra computation. To the writer this does not seem necessary, however, especially where the acquisition of sample plot

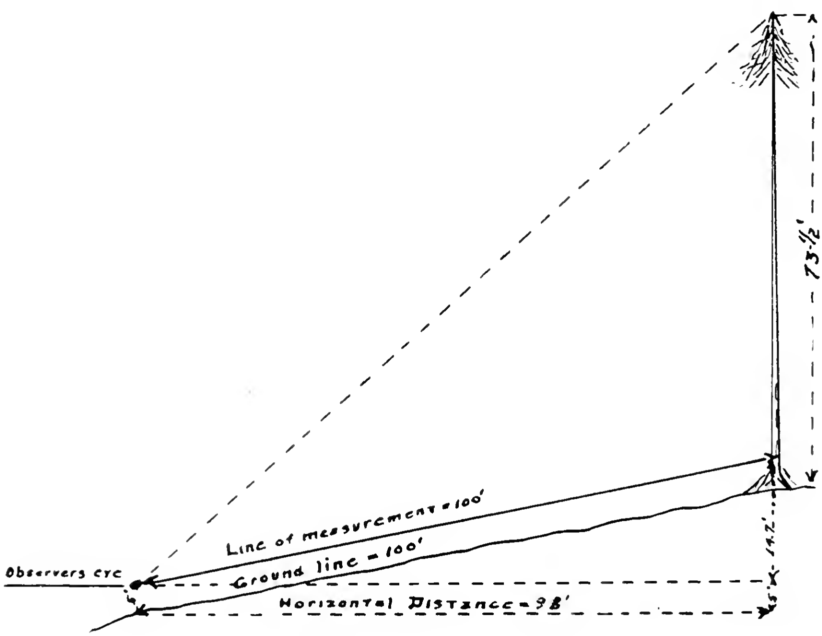

Fig. 2

data is involved. Since the essential data are recorded in the field, the computations for true height readings can be made in the office.

In conclusion, a few remarks in regard to defects in the present type of Forest Service Standard Hypsometer are presented, together with suggestions for using the instrument in a manner which tends to offset them.

Since the graduations on the scale of the instrument represent 5-foot intervals, it is difficult to read interpolations correctly to the nearest

[1] The location of separate points for each tree from which to secure good sights (when only 100 feet or multiples of same are used) is especially difficult in dense stands and results in much loss of time.

foot. In case the observer stands more than 100 feet away from the tree the deviation from the true height is the product of error (in incorrect interpolation) and 1/100 of the excess distance (over 100 feet) from which point the reading is taken. An example will make this matter clear. Suppose a reading taken at 200 feet records 63 feet, the true height of the tree would have computed 124 feet—a difference of $1 \times \frac{200}{100} = 2$ feet. It is obvious that the degree of error becomes greater with increase in distance (over 100 feet). The chance for error under this condition will, however, be somewhat offset, because actual readings (on hypsometer scale) are reduced in direct proportion with increase of distances from the tree, and therefore, since the intervals between the graduations on the hypsometer scale increase in proportion to the lowering of the readings, closer interpolation to the nearest foot is also possible.

Where readings are taken less than 100 feet away the degree of error will be affected by an opposite set of associated factors. In that case the effect of incorrect distances is small and the error decreases in direct proportion with the shortening of the horizontal measurements. On the other hand, the intervals between graduations on the hypsometer scale increase as the horizontal distances are reduced, and accurate interpolation then becomes difficult.

Considering each set of factors which may cause error in computing true heights, it appears that the former are less effective than the latter. This deduction is based on the fact that closer interpolation to the nearest foot is possible when the graduations on the scale are relatively wide.[5] Furthermore, a better line of sight is obtained if observations are made at relatively long distances from the tree. This applies particularly where tall trees are involved, whose crowns are often so flat that the true tip is difficult to perceive. It is then necessary for the observer to choose a point sufficiently far away in order that the angle of sight may be low. In most instances this distance will be considerably over 100 feet.

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[5] In connection with this matter it is recommended that the scale of the hypsometer be graduated to 2½ feet intervals, so far as possible. If this could be done the 2½ marks should be scribed in red, as this would then clearly distinguish from the black 5 etchings.

KNOT ZONES AND SPIRAL IN ADIRONDACK RED SPRUCE[1]

By Edward F. McCarthy and Raymond J. Hoyle

Department of Forest Utilization, New York State College of Forestry

This study of knot zones, spiral, and other defects in red spruce in the Adirondacks had for its primary purpose the determination of influence of these factors on the amount of spruce available for use in the construction of airplanes. The second purpose was the accumulation of data concerning the nature of spiral,[2] with the ultimate purpose of determining the cause and the means of control. Notes were made on the per cent of decay and on such defects as pitch seams and pitch pockets.

AREA STUDIED

Data have been secured from two sections of the Adirondacks to eliminate the influence of purely local conditions of growth and obtain a check upon variations caused by composition of the forest. The first study included measurements made on 988 trees in southeast St. Lawrence County. Advantage was taken of a pulp-logging operation on the International Paper Company's holdings on the Sucker Brook watershed of Cranberry Lake to secure the measurements recorded. The area is on the north side of the watershed and slopes generally southward over rolling land about Curtis Pond. The second study was made following a pulp-logging operation north of Brandreth Lake, in northern Hamilton County. Measurements were here made on 1,314 trees to show spiral per cent and more complete stem measurements to show location of knots were taken on 384 spruce trees.

TYPE OF FOREST

All data were taken on the upland type of forest in which beech and maple form a large percentage of the stand. On the Cranberry Lake area balsam does not extend into this type and the per cent of yellow

[1] Delivered before the New York Section of the Society of American Foresters, at Lake Placid Club, September 6, 1918.

[2] This tendency to growth of fiber that is not longitudinally parallel in the tangential plane to the axis of the tree is discussed by botanists as torsion.

Note.—The authors wish to recognize the valuable assistance of Prof. Ernest G. Dudley in the collection of the field data.

birch is smaller than on the Brandreth Lake area. The humus is deeper on the upland at Brandreth, extending over the lower hills in many places. This factor is closely related to the prevalence of balsam and birch in the stand. The stand at Brandreth approaches the flat-land type between the swamps and the upland and the maximum size of the spruce trees is smaller than on the true hardwood type. No data have been worked up for the true flat type, since the measurements made on 200 trees in the flat did not show differences great enough to warrant the completion of the study of this type. The chief difference found is the smaller range of sizes.

CONDITION OF THE FOREST

Neither area has been cut previous to the present operation for timber other than a probable light selection of pine for shingles at Brandreth before the general lumbering of the Adirondacks. Pine is still standing along pond and stream margins on both areas. The study was restricted to virgin timber land, which alone has spruce timber of size suitable for airplane stock and offers a standard condition to which cut-over lands may be compared.

The present pulp-logging operation leaves the peeled timber on the ground for several months during the peeling season, and checks soon develop which give an excellent opportunity for the measurement of spiral. Striation is visible on the peeled timber, allowing clear definition of the fiber direction even before the checks develop. The season checks often extend several inches into the log and destroy its value for first-grade lumber.

METHOD OF TAKING FIELD DATA

Measurements were made at Cranberry Lake on all timber on the logged area where the tops of other trees did not cover the bole. Care was taken to prevent the exercise of judgment in the selection of trees from interfering with general averages. Measurement of length was made from the ground level to the first pin knot visible, the first half-inch knot, the first inch knot, the top of the dead-knot zone at the base of the live crown, and total height. If the first pin knot was not followed within 2 feet by another, the first was ignored. Stray live limbs were not taken as the base of the live crown. Diameter at breast height inside of bark, per cent of decay on the stump, and the presence of pitch pockets and pitch seams were also recorded. Spiral was measured at the middle of the first log and recorded as straight, straighter than one inch in forty inches, one inch in thirty to forty, one in twenty to thirty, one in fifteen to twenty, or spiraled more than one inch in fifteen. The number of rings in the last inch of average radius on the stump was counted and recorded. Direction of spiral was designated as left if it went counter-clockwise around the bole in looking up the tree and right in the reverse direction. A special effort was made to secure data on the larger diameter classes, so that the number would equal as nearly as possible the smaller classes.

Data were taken from standing trees for diameter classes less than eight inches. It was found possible to measure the degree of spiral from a very small bark incision. In this way it developed that the inner bark had fiber aligned with that of the wood adjoining it, while the direction of fiber in the outer bark might not conform in direction or degree of spiral. The instruments used were ordinary calipers, a straight eight-foot measuring pole, and a small scale.

The same method was used in securing measurements at Brandreth Lake on 384 trees, except that degree of spiral was measured in exact per cents instead of being grouped into classes—that is, a spiral of one inch in twenty was designated as 5 per cent. An additional measurement of the clear zone was taken on the opposite side of the tree from the first knot, and the average height of the clear zone was found to be about three feet above the first knot. Per cent of spiral was measured on a total of 1,314 trees at Brandreth Lake.

DISTRIBUTION OF KNOTS

The diagrams shown are the result of the study at Cranberry Lake. Difference in results are pointed out in all cases where the continuation of the study at Brandreth established contrasts with the first study. The general trend of results was the same.

The study of knot distribution is based on the assumption that the standing merchantable trees cleaned their boles at the same rate as the smaller diameter classes are now doing. While it is recognized that there will be a certain mortality among the smaller diameter classes, there is no evidence of direct relation between this loss and knot distribution.

Three factors determine the extent of the clear length—size of the limbs, rate of decay or erosion in the dead limbs, and the rate at which overgrowth has taken place in a radial direction. The varying influences of these three factors determine the limit of the first three zones in the log diagram.

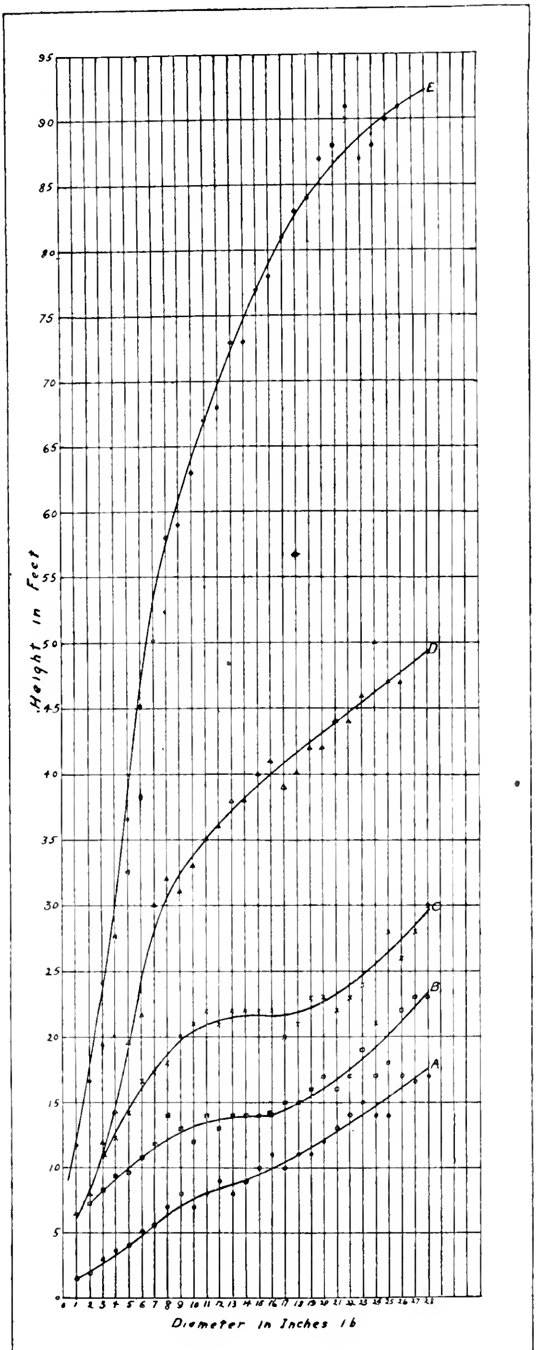


FIG. 1.—*Distribution of knots in the tree bole and total height on the basis of diameter*
Points shown are mathematical averages for each diameter class. Curve A, beginning of pin-knot zone. Curve B, beginning of half-inch-knot zone. Curve C, beginning of inch-knotzone. Curve D, base of the live crown. Curve E, total height.

Field measurements were mathematically averaged for each diameter class and a single point plotted for that average, as shown in figure 1.

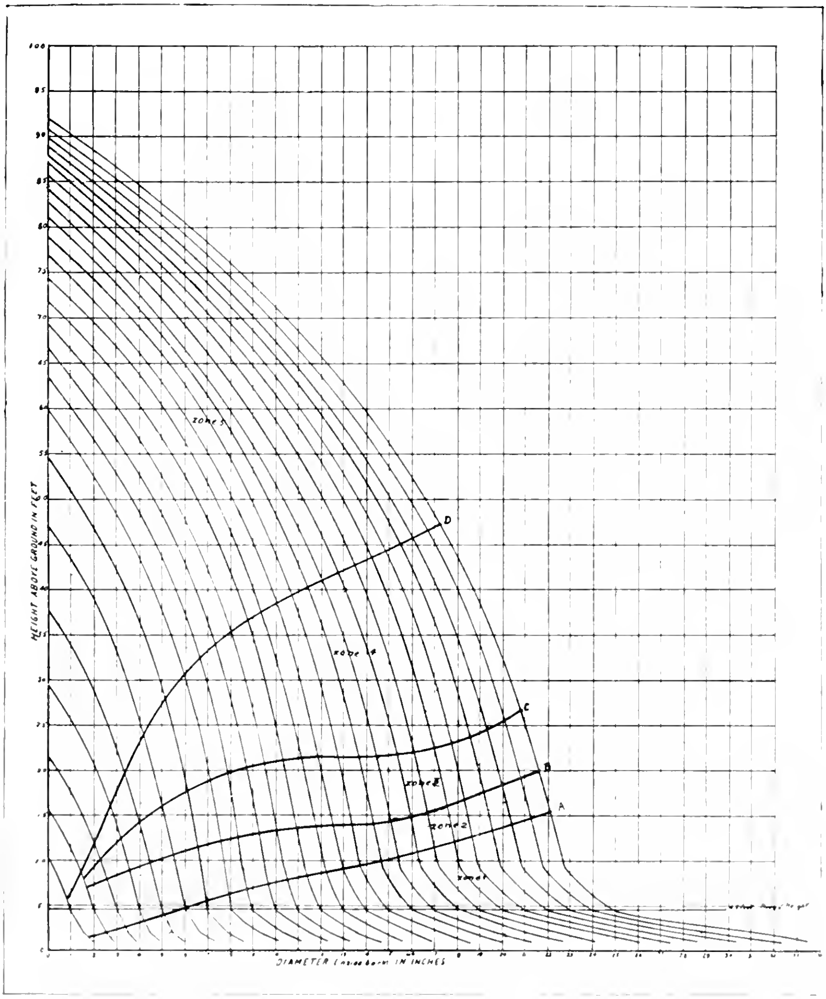


FIG. 2.—*Red spruce, showing zones of absolute clear, dead, and live knots in the tree bole, for each diameter class, inside bark*

Curve A, top of clear zone, free from knots. Curve B, top of pin-knot zone, beginning of ½-inch knots. Curve C, top of ½ to 1 inch knot zone, beginning of 1-inch knots. Curve D, top of dead-knot zone and base of live crown.

Attention is called to the regularity of variation of these points, which determined the direction of the curves with certainty. The apparent irregular flattening of curves B and C, in figure 1, between diameters 12 and 16 may be explained by the increase of size of limbs at a faster rate than the radial overgrowth of the tree bole. The diameter of the limb is determined by the amount of light reaching it in its position on the tree bole, while the diameter growth of the tree bole is determined largely by the height and size of the total crown and is not directly related to the development of an individual limb. It is in fact apparent that the period of time elapsed from the death of the limb is quite as important, if not more so, than the size attained at this point on the bole.

From the curve D it can be noted that the live crown is very low on the smaller trees, so that the live knots will be incorporated in the center of all butt logs. These knots change to dead knots before they are finally healed over. Points read from the curves in figure 1 were plotted on the tree diagram in figure 2. This diagram was constructed from taper tables in Department of Agriculture Bulletin 544, after they had been adjusted to conform to the heights shown for each diameter in curve E, figure 1. Height of the various diameter classes in figure 2 is shown on the vertical co-ordinate. The difference in source of the taper tables used in the construction of the tree diagram and data on live crown obliterates the relation which might be shown between the rise of crown and increase of size of bole at the base of the crown.

Similar data taken at Brandreth on the position of knots show no difference in height of the clear zone to the 11-inch diameter class. Above that point there is a gradual rise, reaching 2 feet at the 22-inch class, which makes the total clear length for 22-inch trees 15 feet. The top of the inch-knot zone corresponds very closely to that shown in the diagram, and the top of the dead-knot zone is about 4 feet higher. The purpose of the diagram is to show graphically the proportionate amount of the tree bole in the various diameter classes which is clear of all knots (zone 1), the amount which contains dead knots (zones 2, 3, 4), and the zone of live knots (5). The large amount of the best grade of lumber which is left in the woods in high stumps is also made apparent.

Dimensions read from figure 2 have been plotted in figure 3, showing diameter less exaggerated in proportion to the length of the log. The first 28 feet of the tree only are shown, since the quality of the lumber above that point renders it of slight interest. Data are submitted in this diagram for the construction of a graded board volume table. Certain variable factors controlling results in such tables must be determined and applied. Saw kerf, dimension limits of lumber, location and size of knots specified in the grading of lumber, alignment of logs on the carriage, and method of cutting (rift or slash sawing) are the chief factors determining the variation of tables constructed from the diagram. Attention is called to the enlargement of the lower 4 feet of the

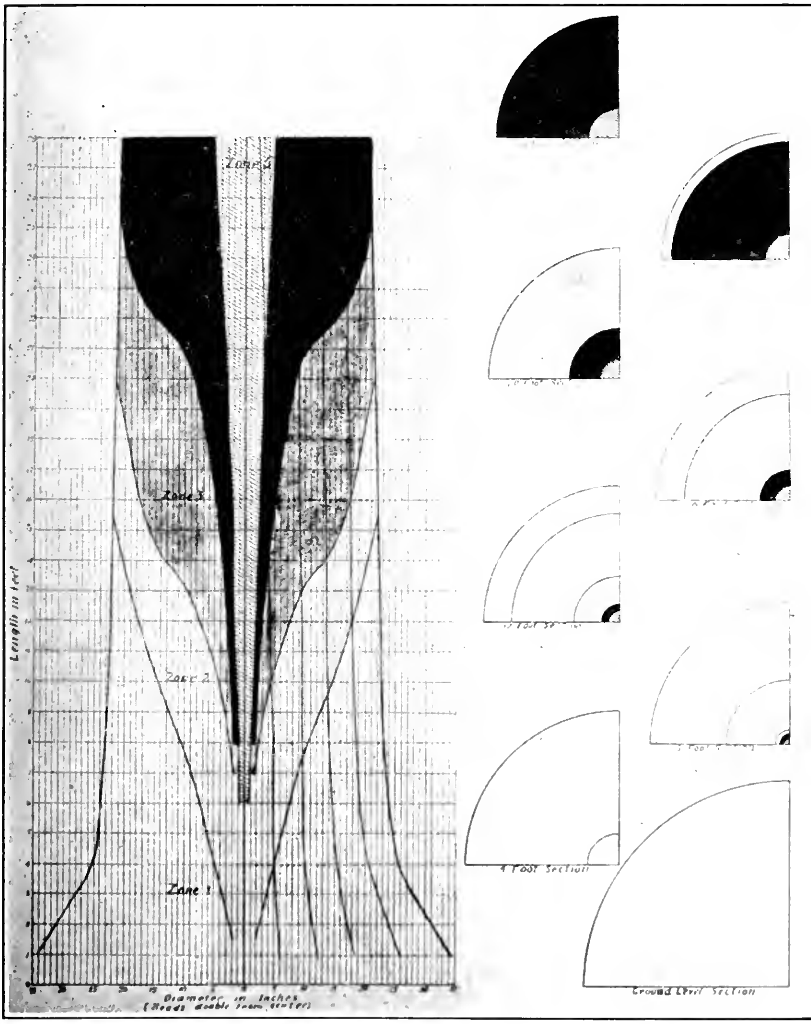


FIG. 3.—*Size and occurrence of knots in the first 28 feet of an average red spruce*

Outer log line shows form of tree 25 inches in diameter 4½ feet from ground, inside bark. Other lines show outlines of 20, 15, 10, and 5 inch trees. Zone 1, clear of knots. Zone 2, dead-pin knots less than ½ inch. Zone 3, dead knots ½ to 1 inch. Zone 4, dead knots over 1 inch in diameter. Zone 5, live knots.

tree bole, which though free from knots will have a crook in the ring grain which cannot be eliminated in sawing the log into lumber.

The study of spiral was extended to cover the poorest grade of spruce lumber accepted in the airplane industry at the time the field-work was

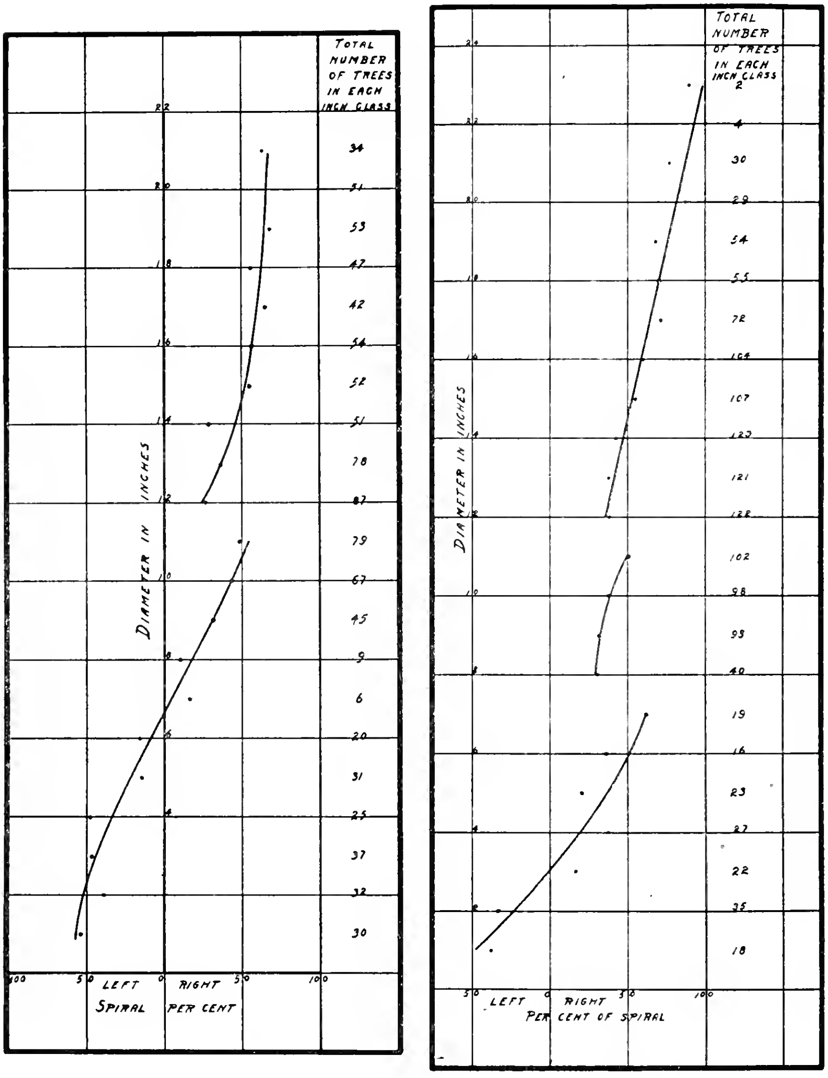


FIG. 4.—*Change in direction and degree of spiral*

Graph on the left from data taken at Cranberry Lake. Graph on the right from data taken at Brandreth Lake. Per cents on the horizontal co-ordinate represent the preponderance in numbers of trees from each diameter class and the direction in which they spiral. Numbers on the vertical co-ordinate show the diameters inside the bark at breast height. Numbers in the right-hand column show the total number of trees in each diameter class and constitute the basis upon which the percentages on the horizontal co-ordinate are computed.

begun. The second study took into consideration spiral of the most severe type by making the measurements on the basis of exact per cent measurements. Classification of spiral in the first field study recognized five distinct classes, the poorest being one inch of departure from the axis of the tree in 15 inches of length. All trees exhibiting a more severe twist of fiber than this were all thrown into one class.

While the measurement of degree and direction of spiral was made at the center of the first log on all trees, it was noted that few trees maintained this same degree of twist throughout the length, and that many changed even the direction from left to right or, more rarely, in the reverse order.

It was observed early in the field study that the trees of larger diameter had a predominantly right spiral, while the smaller classes twisted to the left. Figure 4 is presented to bring out this fact and also to show an interruption in the tendency. At the right of the diagram are shown the numbers of trees measured in each diameter class. The vertical co-ordinate shows the diameter classes and the horizontal co-ordinate shows in per cent the total number of trees in each class, the excess of left over right spiral, or vice versa. It may be noted in the left-hand diagram that up to the 6-inch class there was an excess left spiral and beginning at 7 inches an excess number spiraling to the right. A break is shown in the curve between the 11 and 12 inch classes. It must be remembered that the points are secured by mathematical average, so that a continuous curve cannot be logically drawn. The right-hand diagram shows a similar presentation of data obtained at Brandreth Lake and two quite distinct breaks occur in the curve, one of which conforms in diameter class to that found in the other study. These are interpreted to mean an interruption in the condition of growth, especially light relation, due possibly to severe windfall.

In figure 5 is shown graphically the amount of spiral in terms of per cent of the total number of trees in each diameter-class group. On the vertical line D, which represents a spiral of 1 inch in 20 inches, or 5 per cent curve, No. 3 shows 50½ per cent of all the trees over 14 inches in diameter meeting this specification. Curve No. 4 represents all trees over 14 inches measured at Brandreth and shows 52½ per cent straighter than 1 inch in 20 inches. Similarly curve No. 2, representing trees 9 inches to 13 inches, inclusive, shows them generally straighter than the larger ones, while curve No. 1 shows trees up to 8 inches less spiraled than any other class.

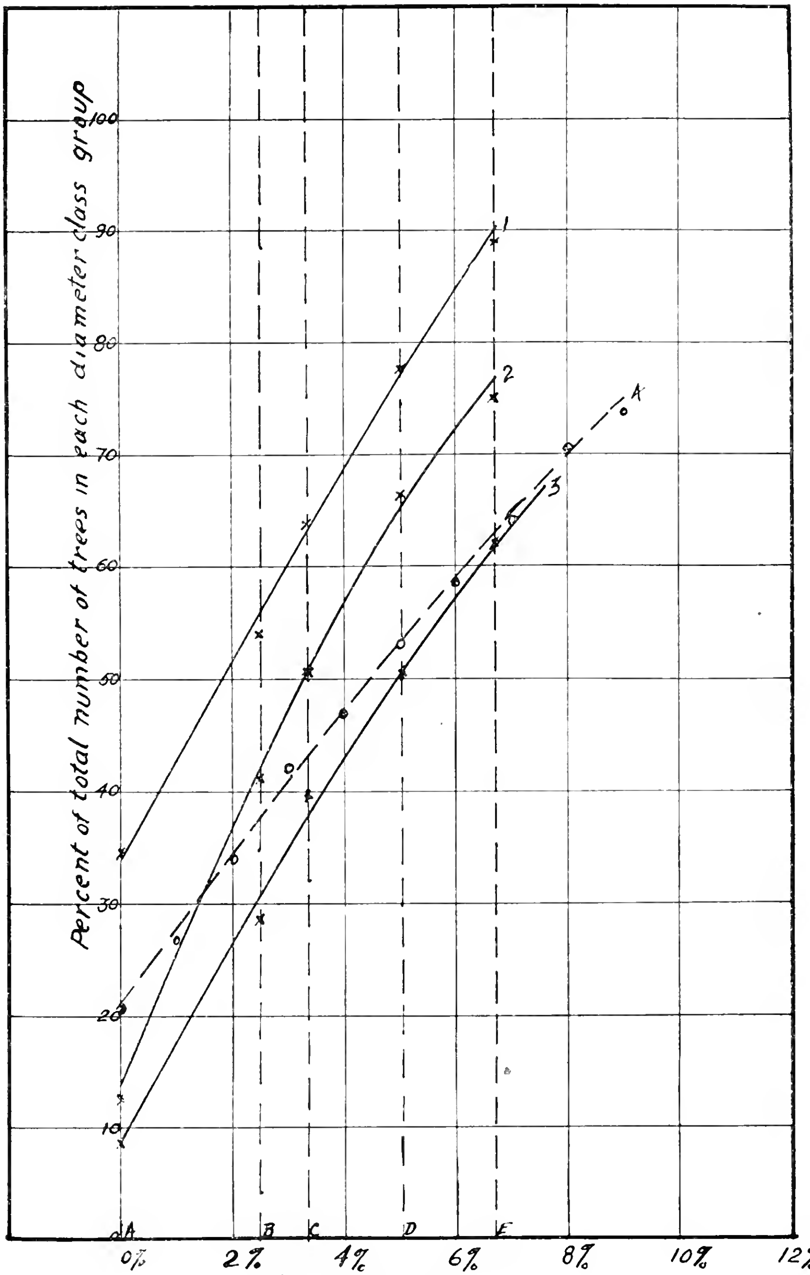


FIG. 5.—*Proportionate amount of spiral in small, medium, and large trees*

Curve 1, trees 1 inch to 8 inches, inclusive. Curve 2, trees 9 inches to 13 inches, inclusive. Curve 3, trees 14 inches and larger. Vertical Co-ordinate A, straight trees. Vertical Co-ordinate B, trees straighter than 1 inch in 40 inches. Vertical Co-ordinate C, trees straighter than 1 inch in 30 inches. Vertical Co-ordinate D, trees straighter than 1 inch in 20 inches. Vertical Co-ordinate E, trees straighter than 1 inch in 15 inches. Curve 4, showing proportionate amount of spiral in trees 14 inches and larger. Taken for comparison from 598 trees on the northeast side of Brandreth Lake, on the Brandreth estate.

TABLE 1.—*Per Cents of Spiral, Showing Proportion of Total Number of Trees Above Stated, Diameter Limits Which are Straight, Which Spiral Less Than 1 Inch in 40 Inches, 1 Inch in 30 Inches, etc.*

(Table not Curved)

	No. of trees	Straight	2½% (1/40)	3 1/3% (1/30)	5% (1/20)	6 2/3% (1/15)
		Per cent				
All trees above 14 inches...	443	8.8	28.6	39.6	50.5	62.0
All trees above 15 inches...	392	8.4	28.0	38.8	49.5	66.1
All trees above 16 inches...	340	9.42	26.8	38.0	48.8	64.0
All trees above 17 inches...	286	10.3	27.3	37.0	48.2	63.7
All trees above 18 inches...	244	11.1	26.2	35.2	46.3	61.9
All trees above 19 inches...	197	11.2	24.9	33.0	45.7	58.0
All trees above 20 inches...	144	12.5	27.1	36.0	48.5	60.4
All trees above 21 inches...	93	14.0	26.9	34.4	45.2	59.3
All trees above 22 inches...	59	11.8	25.4	35.6	45.7	66.0
Per cent as above for all trees 1 inch to 13 inches						
9 inches to 13 inches (inclusive	356	12.7	40.1	50.5	66.3	72.3
1 inch to 8 inches (inclusive)	178	34.8	54.0	63.5	77.5	89.0

To further demonstrate the distribution of spiral by diameter classes, the data are presented for other diameter-class groups than those shown in the curves. It may be noted in Table 1 that the arbitrary diameter of 14 inches chosen for the curve is fairly representative of the other diameter limits above. Large trees are seen to be more severely spiraled than the smaller ones.

Two stand tables are submitted, giving the number of trees above 14 inches. The one taken on Nehasane Park covers sufficient acreage to be an average representation of all the types in the Adirondacks. The other stand table was prepared from the hardwood type on the area studied at Cranberry Lake. It represents an unusually good stand on this type.

TABLE 2.—*Number of Red Spruce 14 Inches and Over on 1,026 Acres in Nehasane Park, 1897, Interpolated from Graded Stand Table, Bull. 26, United States Forest Service*

D. b. h. (outside bark)	Number per acre
14	3.12
15	2.82
16	2.08
17	1.53
18	1.09
19	.69
20	.45
21	.29
22	.20
23	.15
24	.08
25	.03
26	.02

D. b. h. (outside bark)	Number per acre
27	.01
28	.01
29	....
30	.004

TABLE 3.—*Number of Spruce 14 Inches and Over on 37.3 Acres, Proulix, 1918 Cutting, by Inch Classes.*

D. b. h. (outside bark)	Number per acre	Number per acre (curved)
14	3.91	3.47
15	2.81	2.88
16	2.17	2.40
17	1.64	2.
18	2.25	1.66
19	1.26	1.34
20	1.26	1.
21	.59	.74
22	.51	.50
23	.32	.33
24	.16	.20
25	.13	.13
26	.13	.08
27	0.	.05
28	.05	.04
29	0.	.02
30	.08	.01

SUMMARY

Certain conditions were observed and have been demonstrated to exist on the area studied, which are enumerated as progressive steps in the determination of the character and ultimately the cause of the habit of spiral.

1. Spiral grain may differ in degree or direction in various portions of a tree bole from the bottom to the top. This is rather the rule than the exception.

2. Spiral grain may differ in degree or direction from the center to the circumference of an individual tree. This change will be recorded in the bark as well as in the wood.

3. Young trees predominantly spiral to the left and older trees of larger diameter to the right. The time of this change is closely associated with the change in the rate of growth, which is common to spruce trees grown in the mixed forest.

4. An average of about 52 per cent of the 2,372 spruce trees examined are straight enough to pass the airplane specification of 1 inch of spiral in 20 inches.

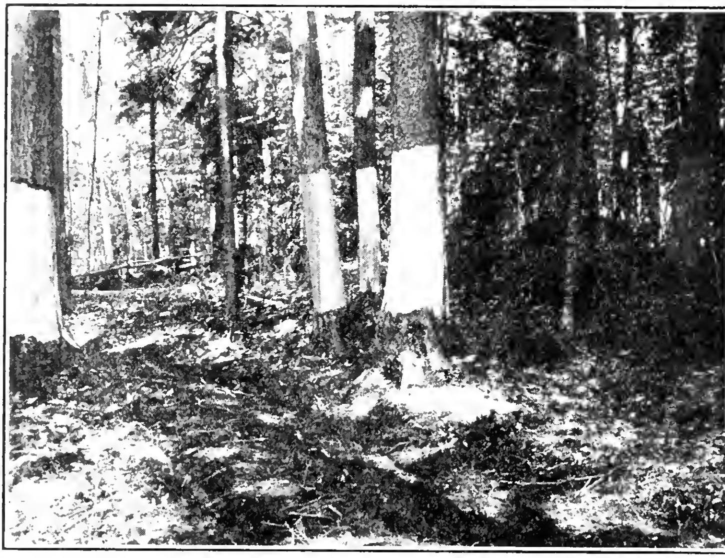
The result of the study made on the distribution of knots shows clear lumber in the outer zone of the butt log only. It is also made obvious that trees less than 14 inches in diameter at breast height are not worth cutting for airplane stock.

Other defects shown by the study still further reduce the available airplane stock. Thirty-three per cent of the 988 trees examined at Cranberry Lake showed evidence of decay. Pitch seams and pitch pockets are prevalent, though actual loss is difficult to compute from these causes.

Deductions for spiral, decay, pitch seams, and pitch pockets will leave less than 30 per cent of the 12.57 trees shown as stand per acre on Nehasane Park in its virgin condition. Of these only a low percentage of the butt log will be free from knots. These facts presented are sufficient to demonstrate the need of action to save the small percentage of high-grade spruce on private holdings from going into pulp wood.

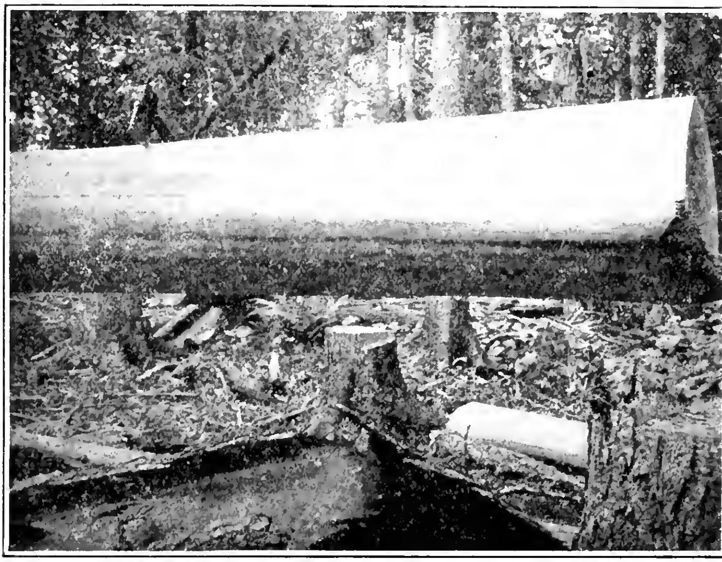
The physiological cause of this habit of spiral growth seems to lie in the change in rate of growth of the outer zone of wood over the fixed core previously established. Distortion occurs while the cells are in plastic condition, and light is doubtless the factor which determines the direction of torsion.

Straight-grained clear spruce tree split in falling, showing prevalence of knots in the heart of all red spruce. The grain of the heart spirals to the left.



Spiral can be detected in the standing tree by a trained expert without the removal of the bark. It is easily seen on the wood when the tree is blazed.

Red spruce large enough to cut clear lumber but spoiled for airplane use by spiral and pitch seams



Clear, straight-grained spruce tree suitable for airplane stock, season-checked after removal of the bark. Tree was cut for pulp.

Spruce log showing severe right spiral and deep season-checks from removal of bark. Log cut a month previous for pulp.

SOME FUNDAMENTAL CONSIDERATIONS IN THE PROSECUTION OF SILVICULTURAL RESEARCH

By Richard H. Boerker

In the following series of articles, in four parts, I am going to attempt to point out some of the fundamental considerations which, in my opinion, should be emphasized in prosecuting research work bearing upon silvics and silviculture. If we are to make logical and sane progress in strictly forestry research, we must first recognize the importance of research work; secondly, recognize the research type of man; third, train competent men in research work, especially in botany; fourth, give them employment; and lastly give them full recognition as scientists, regardless of their ability as organizers, directors, and administrators. In the articles I will briefly comment upon the real significance of research work; the necessity of recognizing the research type of man as something quite apart from the administrative type; the need of training competent research men, especially in plant ecology and plant physiology; the one-sidedness of the present Government research program; and the desirability of divorcing research work as much as possible from administrative work. Furthermore, I wish to propose the formation of an advisory committee of foresters for the purpose of considering the needs of silvical and silvicultural research and for the purpose of considering the specific suggestions which other foresters as well as myself have made and which will be enumerated in Part IV of the series to be published in a later issue of the Journal. These papers will be entitled:

I. What is Research?
II. Recognizing the Research Type of Forester.
III. Training Competent Research Men, especially in the Botanical Sciences.
IV. The Present Status of Government Research Work.

I. What Is Research?

To some foresters it would seem as sensible to ask, What is forestry? as to ask What is research? I dare say many of us have talked about it, read about it, and even written about it without catching the deep significance of this phase of science. Some would say that "experiment" and "investigation" were synonymous terms. Some, I venture, would immediately refer to the facts, figures, and curves which are produced as a result of research.

Research, however, is much deeper than either experimentation or investigation. Experiments are only one means of carrying on research work. Research may consist of just merely reading and digesting great quantities of literature. It may consist of field work, office work, or laboratory work, or a combination of any or all of these. But all of these are only external manifestations that research is being done. They do not give us any clue as to the attitude of the research man towards his work. And this is the *sine qua non* of this class of work. That is the reason it is so difficult to define. It is comparatively easy for a student or research man to acquire facts and principles; but to acquire the research spirit and attitude is sometimes much more difficult. The research attitude may be defined as an inborn love and enthusiasm for desiring to discover and express the truth. Therefore it becomes apparent that a man who carries on experiments is no more a research man than the one who cuts down a tree and plants one in its place can be called a forester, or one who raises a few beets and radishes in a backyard lot can be called a farmer.

Broadly speaking, research is the process by which knowledge is advanced. To secure recognition a profession like forestry must be continuously increasing its stock of knowledge of fundamental principles through research. In our attempt to understand forestry science and its methods much inspiration as well as subject-matter have been borrowed from the older sciences. But foresters cannot let the matter rest there. Forestry science must itself be productive of scientific results and theories.

We often hear the plea that it is necessary to begin silvical and silvicultural research at once and to acquire a knowledge of the basic facts before they are actually needed. It is important to realize the truth in this statement. Research is relatively slow in operation and cannot be hurried. New and fundamental facts cannot be "made to order." Only in very rare instances can they be worked out in time to serve sudden emergencies. Sudden emergencies can only be met if a broad basis of scientific facts and principles has already been established. To secure the best results, research must be carried on continuously from year to year and from generation to generation.

But, you may ask, why is research necessary to advance knowledge? Is not knowledge advanced by other means than research? Empiricism also advances knowledge. We learn things by doing them over and over again or by observing the same phenomena many times. By this means we study merely effects. We may learn the causes involved by this method and we may not. At any rate it is a hit-or-miss process. There is where research comes in; it teaches us to co-ordinate our observations logically and to ultimately arrive at the cause which is behind the effect observed. A recent editorial[1] in the Experiment Station Record, although it deals with agricultural research, explains the reason for research very fully:

"The reason for agricultural investigation and experiment is that our information may be sound, that reason may prevail, that man may act and conduct his operations rationally. In a large sense it is a study of the relationship of cause and effect. Wherever an effect has been observed, there has been a cause, and this cause becomes the object for study. If the purpose is to produce a certain effect, knowledge of the phenomena which cause such effects or influence them must be acquired before the effort becomes more than a hit-or-miss process. The scientific method is that which takes account of all the forces acting. To know the law we must understand the law, and this is equally true of a fact, or a spray mixture, or a method of making cheese.

"Science, whether pure or applied, proceeds on the principle that the same causes acting under precisely the same conditions will produce exactly the same effects. In other words, that nature is ordered by law and that there is nothing arbitrary or capricious in its operations. Chance plays no part, and what we observe is a lawful, natural consequence of causes which we may or may not understand. When we do not understand why certain events occur, it means that we do not understand the forces which acted to produce the events. But there is nothing fortuitous or incapable of being understood through science, either in the elaboration of starch in the growing plant or the benefits from fall plowing."

Thus we begin to understand what research is, what it does, and why we need it. But I cannot leave this part of the subject until I have briefly spoken of the application of research to our present and future prosperity. I wish, for a moment, to digress to the subject of the present war. I think we foresters can learn a valuable lesson from it. At least it ought to broaden our perspective.

The present world conflict has brought out the fact, most forcibly, that we are living in an age of the intensive application of science to the social, economic, and industrial affairs of modern civilization. In fact, in its application to modern warfare, science has progressed to such an extent (or degenerated, if you will) that it threatens to destroy civilization itself. We are living in an age of "applied science" *par excellence*. Peace, when it comes, far from changing the situation, will, if anything, intensify the application of science.

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[1] Experiment Station Record, 36: 4, pp. 302, 1917.

Looking at the causes of the war from a purely philosophical standpoint, we must, I think, agree with Dr. Benjamin Ide Wheeler, who in the commencement oration at the University of Nebraska in June, 1915, attributed the world conflagration to "the cross-purposes of men," which had their origin in commercial and industrial expansion—in other words, in one nation attempting to block the other in gaining possession of world markets. Hence, when peace comes, competition will be keener than ever before and science will come more and more to the fore to aid competition and commercial and industrial expansion.

If science is going to play such a large part in the life of nations, then research, which is the process by which science is advanced, must also play an important part. The wonderful impetus which the war has given to research in every branch of science is but an indication of what we may expect in the keen competition which will come after the war. Take just one example, namely, agriculture.[2] In our own country before the war was a month old there was organized an agricultural committee of the National Research Council. All scientific men capable of rendering service in agriculture or its allied lines were listed throughout the United States. In England about two years ago Sir William Ramsey pointed out the need of vigorous support of scientific research as a war measure. The recent publication by the Board of Agriculture and Fisheries in England of a comparative study of German and British agriculture has shown the advantage to be on the side of Germany, even in the face of less favorable climatic conditions than prevail in Great Britain. A well-organized system of technical education, painstaking investigations at the experiment stations, and trustworthy advice supplied to the farmer have been at the foundation of German agricultural prosperity. That is why Germany shows a greater food-producing power per acre than Great Britain. Professor von Ruemker, of the Royal Agricultural High School of Berlin, put this succinctly when he said, "the great progress that agriculture has achieved in Germany during the last quarter of a century is the result of the union of practice with science." Within the last year France also has awakened to the great present and the greater future need of scientific research. The French Academy of Science recently proposd the establishment of national laboratories of scientific research. A commission of the academy pointed out the necessity of the reconstruction of the entire system of agricultural encouragement, instruction, and research from top to bottom. It observed further that the countries that had developed their

[2] Data from Experiment Station Record, 36: 7, pp. 604-8, 1917.

institutions of research and instruction to the utmost were the countries that have shown the greatest progress and have derived the greatest returns per acre.

Thus it will be seen that the great nations of the earth have recognized the value of agricultural research. It seems to me that the same method of reasoning should be applied to forestry research. If science and scientific research are going to determine the fitness or unfitness of nations for eternal life, then forestry, along with other sciences fundamental to national existence, must realize that empirical facts and unproved theories are not a safe or sufficient basis for future development and expansion.

I have said that this was an age of "applied science." But we must not lose sight of the fact that the fundamental facts must be developed by "pure science" before they can be applied. If "applied science" has made such progress it is because "pure science" made similar progress in advance. Dr. Robert Kennedy Duncan in his "The Chemistry of Commerce" has put this very succinctly: "The achievements of 'pure' science in one generation constitute the formulæ of the 'applied' science of the next, and outside altogether of material application they have their absolute justification."

Therefore, in this age of "applied science" foresters must not lose sight of the value of purely scientific research, for if "pure science" is more fundamental, then the best way to advance "applied science" is by means of purely scientific research. This is the source from which most of our knowledge flows. If we divert or check the course of this river at its source, then the river below will run dry. In other words, if we neglect purely scientific research, in the long run "applied science" is bound to suffer.

II. Recognizing the Research Type of Forester

In Part I of this article I attempted to point out some elementary notions regarding research work and the important place it has come to occupy in the scientific life of the nation. I tried to show how the present war has emphasized the need of research in all branches of science, and how the present age of "applied science" in which we are living must secure its facts and figures by means of "pure science," which in turn is the result of research work. From this it followed that forestry, which is "applied science" *par excellence,* in order to do its share to fit our country for eternal life, must be continuously increasing its stock of fundamental knowledge through research work in silvics and silviculture.

In the present part I wish to apply the principles of the new psychology of work to the selection of forestry men for two distinct lines of work into which all forestry work divides itself. There will always be at least two distinct types of work in all forestry enterprises, no matter whether they be carried on by private, State, or Government interests, and these two types of work will require more or less distinct types of men. Research and experimental work will require research men with a research type of mind, and directive or administrative work will require men with a directive type of mind. In order to give full recognition to research work in all its bearings, it is of the utmost importance that the forestry schools and the forestry departments of the States and the nation recognize the research type of forester and his peculiar qualifications and characteristics as something quite distinct and apart from the administrative type.

There must necessarily, sooner or later, be a combined effort upon the part of the principal forestry schools of the country and sole present employee of forestry investigators—the Forest Service—to recognize research ability in foresters. At least they must learn the lesson that competent work in research cannot be done by men not temperamentally fit for the work and adequately trained in the fundamental sciences. When this recognition comes about, and not until then, can we expect a wholesome and rational development in forestry research in this country.

In selecting men for different branches of forestry work we must employ the new psychology of work, so often referred to lately, as the only rational basis for fitting the man to the job and the job to the man. This psychology recognizes two important facts: that every individual has, upon analysis, certain general traits, characteristics, and qualifications, and that every job, in a similar way, has certain general characteristics. The problem then resolves itself into interpreting the traits of the individual and classifying the characteristics of the job, whereupon the individual is guided into the job for which he is supremely fitted. It thus happens that failure at one job merely points the way to success in a job probably of the opposite type.

The research type of mind is in many ways opposite in character to the administrative type. Research men are apt to be of a retiring disposition; administrative men are often more social and are "good mixers." Investigators are often of a studious nature and they may even be what we call "dreamers." How important this studious habit is in research men may be gathered from what Dr. L. H. Bailey said at a meeting of the Society for Horticultural Science in 1917 and which was reported recently editorially in the Experiment Station Record.[3] In the words of the editor of that journal, Dr. Bailey, commenting upon the kind of men necessary for research and experimentation work, said: "His training must give him a contemplative, reflective habit of thought, and he should always continue to be a student. Unless he continues to acquire much of his preparation as he goes, his research spirit has got its growth."

The student habit is therefore one of the most important characteristics of the research type of man. Yet on the other hand this characteristic is wholly unsuited to the administrator and manager.

The research type is not apt to enjoy jobs of large dimensions, such as managing a National Forest, but he is more likely to feel at home at small intensive jobs, such as fussing or tinkering with minute mechanisms or instruments. In daily life we have just these two types in the bridge-builder or the railway engineer and in the watchmaker. The research type is apt to go to pieces in an emergency, but if given sufficient time will usually act wisely and well. He has slow mental co-ordination; he must have time to reason things out logically. The administrative type, if he is an average one, usually has rapid mental co-ordination and knows just exactly what to do in a crisis. From the nature of his duties, he must blend into any environment and adapt himself to any emergency. The research type is often inflexible and slowly or with great difficulty adapts himself to circumstances. Research men must, above all, be original, and this type of man usually lacks the directive mind. Original men make good designers or artists, but usually very poor superintendents or managers. We often find research men mentally efficient, but manually rather inefficient. It is not often that mental and manual accuracy go together. We know from experience that the best workmen often make the worst foremen.

I do not mean to say that the two types of men are never found in the same person. They are, but these cases are the exception. In the vast majority of cases they are not, and that explains the futility of expecting to find a good research man and a good administrator in the same person. Moreover, I do not mean to say that all research men are born as such. I think that a large majority of men can be trained to do research if the training begins early enough and is reasonably thorough.

It seems to me, if the forestry schools hope to train research men and the Forest Service employ them, these characteristics must be taken

[3] Editorial, Experiment Station Record, 36: 1, pp. 9, 1917.

into account. Forestry students making forestry their life work should make an inventory of their qualifications and try to determine which kind of work they are best fitted for—research or administrative. Forest Service officials should assist in guiding young foresters into jobs for which they are fitted by nature, and forestry professors can go a long way toward advising their students in what branch of forestry work they can be most effective.

In this connection let me turn to Dr. Duncan's book,[4] in the introduction of which he gives some sound advice to those who train research men and also those who employ them. Although what he says refers to men intending to enter the field of industrial chemistry, his whole scheme is very appropriate in this connection. His advice is as follows: After a student has determined to enter the field of industrial chemistry, the next thing he should do is—forget it. The next five or six years he should study all the chemistry he can get without any thought whatever of possible industrial application. He must lay his foundations in "pure science." After he receives employment the employer should not expect any immediate results. He should let the man brood over his work for from two to five years. Experience has shown that such patience is regularly and munificently rewarded. In the meantime the embryo chemist must be kept free from routine duties which can be performed by men of less training. The manufacturer must give him adequate laboratory facilities, and, to a large extent, the factory is his. The only restriction is that he must not interfere with factory operations except in such cases where his theories have been thoroughly demonstrated beforehand.

This scheme recognizes the characteristics of the research type of man and caters to his peculiar traits. Besides, it contains good suggestions both for the forestry school and the Forest Service. Students who later intend to specialize in silvical and silvicultural research should secure a thorough grounding in pure science. The Forest Service should, after employing them, keep them free from routine, give them adequate research facilities, and let them continue to be students both in habit and thought.

III. Training Competent Research Men, Especially in the Botanical Sciences

If our forestry organizations and our educational institutions will recognize the significance of research work in general, and forestry re-

[4] R. K. Duncan: The Chemistry of Commerce. Harper & Bros., New York, Sept., 1907.

search in particular, and furthermore, will learn to appreciate the traits and characteristics of the research type of forester, then they will have no serious difficulty in arriving at an understanding as to the training which the research forester should have in order to be successful. It is very evident that the Forest Service, and other forest organizations, for that matter, are badly in need of competent research men, and, on the other hand, that the forest schools would only be too glad to furnish these men if they knew just exactly the training that was required by them. It seems to me this is an excellent opportunity for an advisory committee, composed partly of forestry school professors and partly of Government research men, to study out and recommend a definite plan of action. This plan must, to be complete, provide for two important needs: a new position in the Government civil service by which research men shall be admitted to the Forest Service, and, secondly, a definite course of study in the fundamental sciences, peculiarly adapted to meet the needs of men specializing in silvical and silvicultural research.

When the administrative field force of the Forest Service was first organized many men secured good appointments and, subsequently, rapid promotion who today would not even be considered properly fit and qualified for the work. Most of them knew nothing about forestry; their chief assets were, perhaps, a knowledge of the western country, a little experience in the live-stock or timber business, and a little business instinct. The research force was organized more or less on the same plan in the beginning, and is, in some respects, to this very day. Men get into research work even now, not because they have had special training, but because they are the best that are available. Their only qualifications are that they have evinced an interest in this sort of work and at the same time have shown administrative ability. Men are shifted from research work to administrative work, and vice versa, according as more men are needed in one line of work or the other. The attitude in general has been that a man for the experiment stations does not differ radically in training or temperament from the kind of man required in administrative work. The result of this policy, or rather lack of policy, has been that a number of men not at all qualified for research or investigative work have been placed in responsible positions at the experiment stations in the past. These men had not only poor training, or no training at all, in botany and ecology, but also, in some cases, poor training in forestry itself.

Bear in mind I am not speaking especially of the men who have charge of the experiment stations today. They are the result, more or less, of a sifting-out process. Moreover, I am speaking not of individuals, but of a system or policy in vogue now about 8 or 9 years. The number of men that have come and gone in this class of work is large. In one experiment station alone more than a dozen have had charge in the last 7 years, to my knowledge.

In the beginning, therefore, a great many men of varying degrees of training were tried out as investigators at the experiment stations. The Forest Service had to use the men they had; there was no choice. The time has come when the large forestry schools should make provision to give prospective research men a thorough and systematic training. Men should not be allowed to drift into this kind of work haphazardly. Only men of special training and the right temperament should be considered and administrative ability should be a minor consideration, because this is not an asset that many good research men possess. But how are we to get properly trained men for this important work? The forestry schools must see to it that men desiring to specialize in this phase of forestry get the proper training in the fundamental sciences. The Forest Service should create a new position for this type of forester and give him some such title as "research assistant" or "forest investigator," and the position should be placed on a par with the present position of "forest assistant" and "grazing examiner" under the classified civil service.

Then comes the question, What should their training in the forestry school consist of? That depends upon the kind of research work for which we think they ought to be prepared. To my way of thinking, silvical and silviculture research is most important. American forestry's greatest present need, I think, is good silviculture. Good silviculture can be born only of sound research based upon careful experiments and observation. Of supreme importance to sound research of this kind is good botany. Good botany courses are more essential, to my mind, than many of the highly technical forestry courses now offered. I believe that those intending to specialize in research can get along without highly technical regulation and valuation much more readily than they can without courses in plant physiology and ecology, intended for use in silvicultural work, principally because sound silvicultural methods can be applied much more widely at the present time than regulation and valuation, which at best have only occasional application.

The man intending to enter the field of silvicultural research needs other courses at college besides those in plant physiology and plant ecology, although these are the most important. He should, among other things, have a good grounding in systematic botany, physics, chemistry, meteorology, geology, climatology, and similar sciences. He should especially study English to enable him to attain clearness of expression; for science is exact in expression as well as in methods. Good training in logic is necessary to weigh evidence and to make logical deductions.

Nor is his training in college the all-important consideration. As I have pointed out before, research is a spirit or an attitude, and the embryo investigator who does not acquire this attitude is swimming against the current, so to speak. A recent editorial[5] in the Experiment Station Record spoke of the training of a research man thus:

"The making of an effective research man or a constructive and original experimenter is a longer and far more difficult process than making a bachelor of arts or of science. The requirements start with the man himself, his temperament, his capacity for right thinking, his ability to receive the impression of high ideals and acquire lofty standards, and his love of truth. There must be a foundation to build upon. If a sifting process could start at this point it would save some time, expense, and disappointment; but such sifting is only partially possible; largely the result must be worked out by experience."

I could go on at length speaking about the training of the research man, but space will not permit it. Moreover, I wish to go somewhat into detail concerning the training which research men in forestry should receive in plant physiology and ecology. I wish to point out the general lack of such knowledge among foresters and offer this as a plea for more and better botany—especially plant physiology and ecology—in our forestry schools.

With very few exceptions, the botany offered at the large forestry schools is inadequate, or, to put it in another way, if the botany courses are there, the foresters do not seem to get them. The one notable exception that has come to my notice is the University of Nebraska. The late Dr. C. E. Bessey, at that institution, saw to it that the foresters were well equipped in botany, because he clearly perceived the intimate relation of botany to forestry. As a result of Prof. Bessey's attitude we count more Nebraska foresters among our best forestry investigators than all other institutions combined.

To go still further, I will say that the botanical knowledge displayed by some of our forestry school graduates is inadequate not only for the needs of the investigator of problems in forest ecology, but inadequate even for the needs of the average practising forester. We have but to go to some of the recent forestry literature to find proof of these state-

[5] Experiment Station Record 36: 2, pp. 101, 1917.

ments. We find in them not only crude similes and misleading statements concerning the fundamental life processes of the tree, but we find actual misstatements of fact. To illustrate my point I have selected at random a few passages from about a half dozen recent forestry books, both elementary and advanced in character, all of them written by either practicing foresters or professors of forestry. Since here also I am dealing with a system or policy and not with individuals, it is neither necessary nor desirable to mention the authors' names nor the titles of the books.

The first passage I happened to come to was this one:

"The leaves are the stomach and lungs of the tree. Their broad blades are a device to catch the sunlight which is needed in the process of digesting the food of the tree. . . . The green pigment, chlorophyll, in the leaf is the medium by which, with the aid of sunlight, the sugars are manufactured."

To speak of the leaves as the stomach and lungs of the tree is to employ two very unfortunate and farfetched similes, the accuracy of both of which must be doubted. The stomach in the animal body is the organ of digestion. The plant has no organ in which the digestive process is centralized; digestion is closely associated with the food storage centers and these may be in widely separated parts of the tree. Likewise the breathing process in the plant is not localized in the leaf; certainly there is no diaphragmatic movement during the breathing process as in the animal body. Therefore it is misleading to refer to respiration in plants as "breathing." Furthermore, sunlight has nothing to do with the process of digestion, which is carried on, as in the animal body, by means of ferments or enzymes. So far as is known, sugars are not manufactured in this way; a very simple carbohydrate—formaldehyde—is the first product. This is elaborated into starch and the starch is changed to sugar for the purpose of translocation. The same author, speaking of stomata and lenticels, writes:

"These pores are necessary for the breathing of the tree (respiration), whereby carbonic acid gas is taken in from the air and oxygen given out. The process of assimilation depends upon this breathing process, and it is therefore evident that when the stomata are clogged, as may occur where a tree is subjected to smoke or dust, the life processes of the tree will be interfered with. The same injurious effect results when the stomata of the roots are interfered with."

Here the same author sadly confuses two separate and distinct physiological processes of the tree—respiration and photosynthesis. Respiration, of course, does not consist of taking carbonic acid gas from the air and giving off oxygen. This is a popular misconception. The respiration of plants is no different from that of animals. So far as is known, roots do not possess stomata.

Another author writes thus of the process of transpiration:

> "The process of taking up minerals in solution through the roots, of depositing these minerals, and giving off water from the leaves is called transpiration."

Transpiration, a passive and unavoidable danger, rather than a function of plants, is usually defined as the evaporation of water from the aërial parts of the plant and certainly does not include the other phenomena the author speaks of.

A third author writes:

> "The leaves are the stomachs of the tree, to which the thin, watery solutions are carried."

This is practically the same analogy made by the first author cited. It is a poor one for several reasons. The feeding processes of plants and animals are not at all alike. The animal eats food already prepared, which is digested by the stomach, for the most part. For the reason already spoken of, the leaf cannot be considered analogous to the stomach of animals. There is also another reason. The plant must make its own food out of food materials, and this is done in the leaves; the leaves are therefore more a laboratory for manufacturing food than a particular place where food is digested. The same author also confuses the two processes of transpiration and photosynthesis, thus:

> "In addition to the transpiration process which results in the giving off of oxygen and water vapor, the tree breathes like any other living organism; that is, it takes in oxygen and emits carbon dioxide."

Transpiration, as already pointed out, has nothing to do with the phenomenon of giving off oxygen. Oxygen is a by-product of photosynthesis and not of transpiration. It appears that carbonic acid (OH. COOH) is by some means reduced to formic acid (H. COOH) and later to the simplest carbohydrate, formaldehyde (H. COH). In the course of this reduction a molecule of oxygen is set free.

The fourth author, speaking of the leaves, writes:

> "The latter serve as the stomach and lungs at the same time. The soluble salts coming in through the delicate cell walls of the root hairs pass up through the sapwood to the leaves. There the water is combined with oxygen, and carbon dioxide found in the air is taken in through the openings, 'stomata,' found on the under side of the leaves. These two ingredients are combined in the presence of a green substance called chlorophyll, found in the leaf cells, to make starch and sugar."

I dare say it must be difficult for the non-scientific reader to picture to himself an organ which functions both as the stomach and lungs at the same time. However, I think I have already pointed out that this is an ill-chosen simile. Likewise the author is not quite clear in his mind concerning the two processes—photosynthesis and respiration. As said above, oxygen enters into photosynthesis as a by-product, and certainly is not combined with the water and soluble salts from the roots and carbon dioxide to make starch and sugar. The presence of oxygen in the leaves may also be due to respiration, but under those conditions it has nothing to do with food elaboration. Speaking of the raw sap coming up through the sapwood, the same author writes:

"After being combined with water and oxygen in the leaves, the energy being supplied by sunlight, the assimilated plant food passes down through the cambium layer."

Besides being a very incomplete statement of what happens in the leaf, this passage contains substantially the same error as the foregoing one.

Still a fifth author writes:

"Now all this time the leaves have been busy taking in carbonic acid gas from the air. This they do by breathing. A tree breathes day and night through its leaves and twigs and through small holes in the bark of the trunk; but most of all through the leaves. The leaves combine the acid from the air with the water and minerals from the soil. The raw food which the roots have sent up is digested in the tree-top.

"Without light and heat trees could not live. For the leaves serve as the stomach of the tree, and they must have warmth and sunshine to help them digest the tree's food. After the food is digested in the leaves it goes back to the tree itself, ready to be used."

This extract contains most of the errors already spoken of. Photosynthesis, respiration, and digestion are hopelessly confused.

The last example I wish to cite is the case of a forester who wrote a paper dealing with the importance of street trees and the many important reasons why they should be planted in the streets. One of the benefits which he mentioned was the fact that the leaves of the trees absorb great quantities of atmospheric moisture from the air and in this way drain the air of humidity, thus making a hot, sultry, humid day drier and more bearable to city inhabitants.

Were I to take such a collection of passages from a number of popular nature-study books written for children by unscientific authors, I would not be surprised. But I am positively astonished to find such statements as these made by competent foresters, all of whom are graduates, most of them postgraduates, of the foremost forest schools of the country. Aside from the ignorance displayed on the part of the authors of fundamental things in botany, such statements as these must be misleading and confusing to the lay reader, to say the least. From a professional standpoint, in the infancy period of "American forestry" these errors are deplorable. In the eyes of European foresters it might make American foresters appear in rather a bad light; also, should European foresters judge our forestry practice by some of the statements in our forestry literature, it would be greatly to our disadvantage. Last, but not least, is the fact that these errors and ones like them make a healthy and sane development of scientific forestry impossible, to say nothing of the development of research in silvics and silviculture. The forestry superstructure of the future cannot and must not be reared upon so poor a foundation. The need of more and better botany in our forestry schools, I think, is very evident.

LANDS PROBLEMS

By C. J. Buck

The work in the office of Lands is at present (February, 1918) in a transition stage. Some lines are decreasing to a very gratifying extent and new lines of work are opening up a series of problems which the future must solve.

The success, I may justly call it, in solving some of the difficulties of the older and more vexing lands problems has raised the question as to whether the office of Lands is not finishing its duties and working itself out of a job. Such a comment strikes a very satisfactory response in one who has wrestled with these problems for years—problems which some members of the Service were beginning to feel were impossible of ready solution. Lands work and lands problems will be just as important and as difficult in the future, but along somewhat different lines.

Lands work is fundamentally that of the mother office of the National Forests. After the Forests were created, it became necessary to protect and administer them. The office of Organization was then created to handle this line of work. The selling of timber and the practice of silviculture naturally grew into another office.

The beginning, being the boundary work or the creation of the Forests, the next step in Lands work was naturally to conserve the boundaries of the Forests and to protect the land in its Government ownership, which involved the protection of the areas from adverse and ill-advised legislation and from fraudulent acquisition under existing legislation. In order to conserve these boundaries, it was early found that certain additional legislation was needed, such as the repeal of the old lieu land law. A fundamental National Forest lands policy was also absolutely necessary, and that policy early involved the idea of the highest use—the best use of lands by the greatest number of people. As a natural concomitant of this policy—and without which the National Forest system could not stand—it became necessary to release agricultural lands where such use was the highest. This was one of the most troublesome problems and one which the Forest Service has in a large measure solved. New phases of the problem will no doubt continually arise, yet it appears certain that with a proper organization each will be solved in a satisfactory manner under the land classification principles which have been evolved as a result of long study and experience.

The presence of agricultural lands in the National Forests was early found by opponents of the Forest Service to be one of the strongest grounds on which they could attack the National Forest system. At the same time the fathers of the National Forest system saw that a new law was necessary for the release of such lands in an orderly and proper manner.

The first law relating to the presence of agricultural lands in the Forests is found in the Act of June 4, 1897, which provided that lands found to be more valuable for agriculture or mineral should not be retained in the National Forests. This act alone was unsatisfactory, since the agricultural tracts were so small and scattered that it was not practicable by executive orders or proclamations to eliminate them and open such lands to the homesteader. This was the reason for a fight for a law which finally resulted in the Act of June 11, 1906. Before the passage of this act, there had been considerable agitation for release of large tracts of alleged agricultural lands. The pressure was therefore considerable and the Forester issued instructions calling for immediate examinations and opening to settlement of agricultural lands which might be applied for. Perhaps more attention was given at this time to immediate action than anything else. Possibly immediate action was the greatest public need. However, the natural result under the loose instructions, lack of experience, and haste was the opening among the agricultural lands of many tracts having little or no permanent agricultural value and some tracts having a considerable timber value. This continued through 1906, 1907, and 1908. In 1909, 1910, and 1911 examinations of large numbers of applications continued, the only difference being that whereas formerly the examinations were made by a few men traveling from one National Forest to another and often unfamiliar with local conditions, they were now made more largely by the ranger force, which consisted of men familiar with local conditions, but lacking in perspective or basic understanding of the real value and purpose of the work. The action considered proper was in a great number of cases found inconsistent with earlier action which had been taken. Thus was given cause for considerable agitation and complaint.

The establishment of the district organization in 1908 was the greatest step ever taken for the solution of lands problems. Men more in touch with field conditions had more authority and thus an opportunity to better investigate and arrive at a more clear understanding of the problems. About 1910 we saw clearly that classification of whole watersheds was the only solution. Individual cases acted upon by different men with different understandings of the problem and of the situation resulted in inconsistency and many times in improper action. The first classification project in this district was probably on the White River, on the Wenatchee, where we covered the whole watershed, obtaining very reliable information on which to reject an ill-advised petition for elimination which had been signed by local people and by the local Forest force as well, and delineating each tract of agricultural land after reserving necessary ranger stations.

We still continued classification work by watersheds in 1911 and 1912, and beginning with August 10, 1912, an appropriation was secured from Congress for the purpose of delineating agricultural lands with greater expediency than heretofore. This resulted in giving us the final solution of the problem. The Forester immediately began to formulate a land classification policy and procedure which could be understood and applied everywhere. For the first time agriculture was defined as meaning the production of farm crops under established farm methods. Meetings of lands men were held and drafts of instructions drawn up and continually bettered until about 1913, when a policy of classification, based on the best ideas found in all the Service, was adopted, and all logical points were finally worked into the instructions and a systematic and final appeals procedure approved. At this time, also, the Bureau of Soils experts were assigned, through an appropriation made to that bureau, to assist in arriving at the agricultural values of lands within the National Forests. Their reports were considered, together with the Forest Service reports by the Forester, in finally approving action on the projects.

As a result of the extensive and intensive classification, practically all lands in Oregon and Washington—in fact, all National Forest lands in the United States except 50 million acres, 20 million acres of which are in Alaska—have been finally classified by the Secretary; 12,039,736 acres have been eliminated, 493,863 acres of which are in District 6.

Those closest to the lands problems early found that the elimination of areas whose presence within the Forests could not be justified was one of the very strongest measures toward protection of the integrity of the Forests themselves. They also found that these eliminations should in all cases be based on the initiative of the department and not on the initiative of petitioners. Eliminations based on petitions very seriously affect the stability of the National Forest boundaries. The action in these cases by the department is presumed by the people to be based upon their petitions, and they often then have no hesitation in requesting eliminations of timbered lands or any other areas, no matter how properly they may be in the Forest. The exercise of initiative by the department in this regard removes the possibility of delayed action based on public petitions, and clarifies the boundary situation by making it apparent and reasonable on the ground what character of land is National Forest land and what is not. For the last few years the lands work in the Service has been so organized and the policies so well developed that decisions are early reached and action taken either to eliminate or retain lands reported in classification reports, and the logical reasons are on record for the action taken in each case. The action is therefore defensible, and any petitions subsequently received are immediately considered and a justifiable and reasonable conclusion reached.

One of the most difficult lines of work has been the protection of the Forests from fraudulent claims. Early in the administration the land office was instructed to obtain reports from the Service on land claims in the Forests. To properly protect the Forests it has been necessary to examine all claims, and it has been necessary through the legal staff to combat through land-office procedure many fraudulent claims involving millions of feet of the most valuable timber. The present-day labor on these cases involves mineral claims, coal claims, oil claims, reports on claims under the Act of June 11, 1906, of which there are a considerable number, and applications for reduction of cultivation under the homestead laws.

Of our present-day problems, the land-exchange work and the recreational and other uses loom the largest.

Nearly 12 per cent of all lands within the boundaries of the National Forests are privately owned, and 14½ per cent of all lands inside the boundaries in Oregon and Washington, or 1,681,830 acres, are privately owned. Most of this area is non-agricultural timber lands, some of which has been cut over. The presence of these privately claimed lands increases the cost of administration and decreases its effectiveness, both in fire protection and in silvicultural and other work. The big work in front of the office of Lands is to segregate the private from the Government lands to the benefit of both parties. Special acts have been passed for this purpose on some Forests, such as the Paulina and Ochoco acts, which provide for exchanges on the basis of equal area and value. This form of legislation, although in advance of the old Forest Reserve lieu land exchange law, which provided for exchange on the basis of equal area alone, still leaves much to be desired. It is difficult to work out an exchange on the basis of equal area and value. Usually the private owner cares very little about area. It is value for timber and grazing in which he is interested, these being the only two marketable values found in most cases. A more advanced legislation provides for exchanges on the basis of equal values without regard to area or National Forest timber for cut-over lands. The Oregon exchange act, designed to remove private lands from the Bull Run Division of the Oregon Forest, provides for equal value exchanges. The law, which was approved September 8, 1916, reads:

"That for the purpose of consolidating forest lands belonging to the United States within the Oregon National Forest, the Secretary of the Interior be, and he hereby is, authorized and empowered, upon the recommendation of the Secretary of Agriculture, to exchange, upon the basis of equal value, lands belonging to the United States in the Oregon National Forest for privately owned lands lying within the exterior limits of the Oregon National Forest; and upon the consummation of such exchanges, the lands deeded to the United States shall become parts of the Oregon National Forest."

The most advanced legislation along these lines was enacted with reference to the Whitman National Forest. This law provides that timber in or near the Forest may be exchanged for private lands in the Forest. This same act, by the way, provided for an addition of 50,622 acres to the Whitman Forest, most of which is patented, but most of which will eventually, through a series of exchanges, be acquired by the Government for the National Forest in exchange for Government timber. A general land-exchange law has been advocated by the Forester and Secretary for the past few years and there is reason to hope for its passage. One of the bills so introduced provides:

"That for the purpose of consolidating the Government lands within National Forests and where the public interests will be benefited, the Secretary of the Interior is hereby authorized to accept title to non-mineral lands within the exterior boundaries of the National Forests, and, upon recommendation of the Secretary of Agriculture, to exchange non-mineral Government lands within any National Forest, or timber within such Forest, for privately owned lands of equal value and chiefly valuable for National Forest purposes within the exterior boundaries of the same National Forest; and, upon the acceptance of title, lands deeded to the United States within National Forests shall become parts of the National Forests in which they are situated; *provided*, that not more than two hundred thousand acres shall be exchanged within any calendar year."

It will take a great many years to get these exchange problems settled. Work on them has gone slowly in the past, since no special appropriation has been made and very little encouragement has been met with in obtaining such an appropriation. The largest exchange we have on hand is provided for by a special act of Congress confirming an agreement between the Secretary of Agriculture and the Land Board of the State of Washington. This exchange involves something under a half million acres of unsurveyed school lands in the National Forests, which, under decisions of the Federal courts, are in reality in Government ownership, but are still lands the possession of which the State has been deprived of through creation of the National Forests. As the State's title does not take effect until the lands are surveyed, the inclusion of the land in the Forest prior to survey deprived the State of title. It has therefore always been considered equitable that the State should receive value for such lands. A cruise of the base lands of the State of Washington has been completed and as much of the area selected by the State and approved by the Service as the General Land Office has been able to survey. This exchange will be effected on the basis of equal area and value.

Four or five years ago the nation's attention was turned to the wonderful recreational facilities and possibilities for tourist trips to National Parks and other points in this country, this movement being promoted probably by certain railroads and by considerable advertising of National Parks. The Forest Service also publicly invited people into the Forests for recreational purposes, thereby opening up a new and somewhat difficult problem. At the same time, in order to attract and obtain the highest use of certain areas valuable for recreation, a term-lease law was passed by Congress providing for the erection of summer homes, hotels, and other similar public conveniences in the National Forests. Our problem now is to classify and develop all such existing areas. All individual camp sites which demand a considerable amount of improvement and are of paramount importance are handled as Service projects, approved by the Forester. Two such sites we are now developing in this district—the Eagle Creek Camp Grounds, on the Oregon Forest, on which $6,000 has been spent, and the Denny Creek Camp Grounds, on the Snoqualmie. These grounds will serve for the accommodation of a large number of visitors. During the past season approximately 532,300 recreationists visited the National Forests in this district, approximately 100,000 visiting the Eagle Creek Camp Grounds alone.

The improvement and consequent use of these camp grounds by the public has been actually demonstrated to result in considerable saving in protection work from campers' fires, which in the past have usually offset the expense of the improvement work performed.

National Park agitation, covering such places as Mount Hood, Mount Baker, Lake Chelan, Mount Olympus, additions to the Crater Lake Park, additions to the Mount Rainier National Park, etc., have afforded considerable of a problem. The attitude of this department in the matter of the creation of these new parks and additions has been worked out and is about as follows:

When the proposed park is inside the National Forest, the Forest Service naturally is interested, because the land is already reserved primarily for timber and watershed purposes and has been protected and improved for years. It must also consider the proper administration of any remnants left in the Forest. First consideration should be given to the needs of the nation as a whole. There are some areas in the National Forests, such as the Grand Canyon, which should be made National Parks. However, to be desirable as a National Park, it is necessary that an area should (1) contain natural wonders of a genuine national importance; (2) its paramount utility should be for recreation and landscape features; (3) it must be a practical administrative unit as a park and its creation must not so seriously disturb National Forest administration as to offset any possible advantages in the change of administration. The creation of National Parks should result from a national demand and not merely as a result of local exploitation for the purpose of securing advertising and federal road aid.

In closing, one point I wish to add is that the disposition of National Forest lands is fundamental. It determines where the Forest Service is and what it is able to do. The reservation of public lands in the National Forests, the eliminations therefrom and the additions thereto are points which touch the public interests and all that concerns Lands work is continually looked into by the public. Private individuals have much to gain or lose by decisions in thousands of cases coming before the office. Numerous bills are introduced, and some of them are approved by Congress, vitally affecting in one way or another the integrity of the National Forests, in all of which it is the duty of the office of Lands and of the Forest Service to know its import and its scope and to formulate a policy and procedure commensurate with its intent, the good of the Service, and the benefits intended to be conferred upon the people.

REVIEWS

Range Preservation and its Relation to Erosion Control on Western Grazing Lands. By A. W. Sampson and L. H. Weyl. U. S. Dept. of Agriculture, Bulletin No. 675, June 25, 1918, 35 pp.

With the rapidly increasing demand for available forage the western stock interests are keenly alive to the importance of investigations that have for their object the improvement of the carrying power of much of our western range. Sampson and Weyl have recently published the results of a comprehensive study on the relation between range preservation and erosion and its control on grazing lands in the West. The bulletin has 35 pages of printed matter, well illustrated by photographs, diagrams, and line drawings. The data were obtained, for the most part, on the high summer range of the Manti National Forest, in central Utah, where conditions influencing erosion are similar to those prevailing in most mountainous areas between the Rocky Mountains and the Sierras of California. The study as originally planned will require a number of years, but the data already available are considered so important they are published prior to the completion of the study. After outlying the purpose of the study, emphasis is placed upon the damage caused by erosion. On the areas studied the greatest damage from erosion was when overgrazing was practiced and the ground cover destroyed or seriously impaired. Before these areas were overgrazed and the ground cover impaired, erratic run-off and erosion were practically unknown. It is pointed out that the damage is not confined to the decrease in the forage yield and the silting over of adjoining agricultural land, but the efficiency of the watershed in maintaining a permanent flow of irrigation water is greatly decreased. When the range has been grazed destructively, the economic balance between range and live stock on the one hand and farm land and farm crops on the other has been greatly impaired. A number of typical examples are given of the damage from erratic run-off and erosion following overgrazing. As one example, a rain of 0.55 of an inch, the greater part of which occurred within an hour, fell at the head of Becks Canyon on July 20, 1912. Although the rain started at 11 a. m., at 11.45 a. m. a flood was pouring out of a side canyon from an area of less than 1,500 acres at an elevation of 10,000 feet. The soil, denuded of vegetation due to overgrazing, was clay-loam. There was little outcrop of rock and the slopes were moderately gentle. An examination showed that the soil had been densely backed by grazing previous to the storm, yet the whole of this small watershed was well marked with gullies, due to the storm. The flood water where it reached the mouth of the side canyon presented a front about 8 feet wide and 1½ feet high. The water was so filled with sediment that it did not flow, but rolled over and over. In a short time the flow increased to a front of from 10 to 25 feet wide and from 6 to 8 feet high. Owing to the enormous deposits of débris, the course at the mouth of the channel changed three times during the progress of the storm.

In order to determine the factors controlling the amount of erratic run-off and erosion in 1912, two areas as similar as possible in topographic, soil, and climatic conditions and in vegetation were selected for study. These areas are at the head of Ephraim Canyon, on the Manti National Forest. There are no permanent streams on either area, run-off occurring only after rain storms and from melting snow.

Comprehensive studies were made on each of these areas regarding the amount and character of the run-off following the melting of the snow in the spring and following rain. It is shown that erosion from melting snows is a more serious factor than generally supposed when the vegetation cover is sparse and the slope steep or even moderately steep. Out of 26 rain storms for the year 1915, distributed over the four months from June to September, only one storm produced run-off. During the following year there were several rain storms during the same months, covering a period of two to five days each, which produced run-off. In cases where the rainfall continued after the soil became completely saturated, run-off occurred and carried with it a large amount of sediment. In general, the extent of erosion and run-off on the two areas following rains depends upon (*a*) the rate at which the rain falls, (*b*) the steepness of the slope, (*c*) the presence of well-established gullies, (*d*) the character of the soil, and (*e*) the density and character of the vegetation.

Following the destruction of the vegetative cover by overgrazing at high elevations, wind movement becomes particularly active in the translocation of soil. Investigation of wind velocity at different elevations during the growing season, which is the only time the ground is exposed at high elevations, showed a movement approximately 100 per cent greater in the spruce-fir type at 10,000 feet elevation than in the aspen type, 1,500 feet below. Not only has the wind greater velocity at the higher elevations, but the vegetation is usually much less dense, and as a consequence wind movement of the same velocity has a much greater effect. It is especially important, therefore, that the vegetable cover at high elevations be maintained at the maximum degree of density in order to bind the soil and prevent its blowing about.

In the study of the relation of erosion and soil depletion to the vegetative cover, it was ascertained that all the principal salts in the soil useful in the growth and development of plants, except potash, were much more abundant in the non-eroded soil, the greatest difference being in the total nitrogen content. Due to the greater loss of organic matter, the eroded soils were found to have a maximum water-holding capacity of 46.8 per cent, while the non-eroded soil had a capacity of 67.2 per cent. The "non-available" water was found to be 15.6 per cent in the eroded soil and 19.3 per cent in the non-eroded soil. There remained for the vegetation 16.7 per cent more water in the non-eroded soil than in the eroded soil.

By growing peas and other plants on both the eroded and non-eroded soils it was found that there was a remarkable contrast in growth on the two soils. The total dry weight in peas produced was as 1 to 8.3 in favor of the non-eroded soil. Native brome-grass and other species behaved in similar manner. The conclusion is drawn that erosion is detrimental to plant growth, chiefly because it brings about the two following conditions of soil impoverishment: (*a*) Lack of adequate soil moisture, due to the lowered water-holding capacity of the soil, and (*b*) lack of adequate plant nutrients in the soil, due to reduction in the soluble plant foods.

The bringing back of the original desirable forage plants on eroded soil whence they have disappeared, due to overgrazing, is extremely difficult. Observations on the Manti National Forest, extending over a period of four years, show that the character of the vegetation following overgrazing depends upon the degree of erosion and the resulting soil depletion. Where the fertility of the soil has been seriously impaired, only rapidly growing and early maturing annuals first occupy the soil. In time, through the elimination of overgrazing, soil fertility gradually improves and the longer-lived, deeper-rooted, more valuable forage species gradually reappear. To completely re-establish the more desirable and perennial species, however, such as occupied the soil before it became depleted, requires years, coupled with expert management. Special emphasis is placed upon the importance of preserving the dark-colored surface soil and in taking the necessary precautions when incipient erosion becomes apparent.

The maintenance of a maximum cover of vegetation and the continuance of grazing are antagonistic, and unless recognized principles of range management are practiced there is always danger of impairing the ground cover, followed by erosion and soil depletion.

The maintenance of an acceptable soil cover and the continuation of grazing demand the recognition of the following principles of range management:

1. Avoidance of overgrazing.
2. Avoidance of too early grazing.
3. The practice of deferred and rotation grazing.
4. Artificial reseeding.
5. The control and distribution of live stock.

In certain cases damage from long overgrazing can only be overcome by the total elimination of live stock and by later terracing, planting, and dam construction in order to check the surface flow of water in the eroded channels.

The chief merit of the publication is the application of instrumentation and exact methods of study to problems of grazing and erosion which heretofore have been approached by the observational method. Although no entirely new principles have been brought to light, we have in this bulletin more convincing evidence than heretofore that grazing on public lands at high elevations demands expert supervision or serious damage from erosion and soil depletion may result and the nation thereby suffer great economic loss. J. W. T.

Seasoning of Wood. By J. B. Wagner. D. Van Nostrand Company, N. Y., 1917. Pp. 274.

This book, which is distinguished mainly by its typographical excellence, begins with a discussion of the structure of wood, largely obtained from U. S. Forest Service publications. This is followed by the inevitable "list of important woods," which contains much valuable information, as, for instance, the assertion that the resinous smell of western yellow pine is very remarkable. We learn that Douglas "spruce" grows very large in the Pacific States, to fair size in all parts of the mountains, in Colorado up to about 10,000 feet above sea-level! We also learn for the first time that Douglas "spruce," or, as the author has it, *Pseudotsuga douglasii,* has a rival in *Pseudotsuga taxifolia,* or "Red fir." Mr. Wagner also presents the information that *Tsuga mertensiana* is used for pulp wood, floors, panels, and newels, and that it is not suitable for heavy construction, which will be comforting to a number of foresters in the Northwest who have occasional patches of mountain hemlock under their care. Western hemlock is not even mentioned by the author, which leads the reader to wonder if it was omitted in a spirit of facetiousness. Mr. Wagner also is apparently not aware of the fact that western red cedar, which he calls canoe cedar, is occasionally used for shingles, and so on, *ad infinitum!*

Following the list is a discussion of the grain, color, odor, and weight of wood, which is well written, being appropriated bodily from Bulletin 10 of the Division of Forestry, to whom no credit is given for either the text or the illustrations. This is followed by a chapter on the "Enemies of Wood," which was also obtained in a similar manner.

The chapters on the seasoning of wood show that the study of Forest Service literature and other literature is of value, for the author apparently has a good abstract grasp of the situation. The final chapters, on the types of dry kilns and dry-kiln accessories, are well illustrated with illustrations supplied by dry-kiln manufacturers. B. L. G.

Control of the Gipsy Moth by Forest Management. Part I. The Gipsy Moth in Woods. By G. E. Clement. *Part II. Management of Typical Woodlots Infested with the Gipsy Moth in the White-pine Region.* By Willis Munro. Bulletin 484, U. S. Department of Agriculture. April, 1917. Pp. 54.

The gipsy moth was first liberated in New England about 1869. Since 1888 it has become a serious pest on shade, fruit, and forest trees. "Satisfactory means of protecting the first two classes of trees have been developed, but they are too expensive to be practicable in the case of forest trees." The fact that "foliage of some species of trees is more acceptable as food to gipsy moth caterpillars than that of other species," and that "caterpillars in the first stage of their development do not eat the foliage of conifers, except tamarack," opens up a field for the employment of forest management in controlling the gipsy moth. Since 1912 an investigation has been in progress under a coöperative agreement between the Bureau of Entomology and the Forest Service to determine "in what proportions trees of different species can be associated to form stands which will not be subject to gipsy moth ravages" and "the best method of converting existing stands into others better able to resist attack." The field work is based on sample plots established to represent a variety of conditions. This bulletin is in the nature of a preliminary report. Details of the behavior of the gipsy moth in the woods are given and the composition and condition of the woods in the infested territory discussed. A colored map showing the boundaries of the infested district with relation to the four forest regions is included. In presenting this map a curious mistake has been made by assigning the Connecticut River valley through Massachusetts to the sprout hardwood region, while north and south of this section the same valley is placed in the white-pine region. As yet broad belts on the western and northern sides of New England are free of the gipsy moth. The common trees (75 species selected) are divided into four classes, depending on the degree to which their foliage is favored as food by the gipsy moth larvæ. This list, the discussion following, and the recommendations at the end of Part I, should be studied carefully by woodland owners in the infested territory with the purpose of selecting the proper species to favor in forest management.

The purpose of Part II is "to co-ordinate the results of the food-plant experiments with known principles of forest management and with economic conditions in the infested region, to see how far we may reasonably expect to rely upon forest management to control the moth." Management must be based largely upon the susceptibility of the stand to gipsy moth attack.

Munro finds that out of the 75 tree species listed in Part I, only 18 are what may be termed "controlling trees," so far as management is concerned. Six representative sample plots in Massachusetts, Maine, and New Hampshire are described in detail, and recommendations for management according to one, two, or three different plans are laid down for each plot. This is the most valuable part of the bulletin for the average woodland owner.

In general, for stands containing a large proportion of favored food plants, removal of the stand in one or two cuttings, planting of conifers or immune hardwoods like white ash, with several cleanings, is advised. Where the proportion of favored food plants is small, cuttings to remove these species without subsequent planting may be sufficient. In some stands a special "gipsy-moth cutting" must be made. Under certain natural and economic conditions the selection system should be used. In his conclusions on the possibility of overcoming the moths by forest management Munro says: "Each lot and each combination of species presents a problem in which the controlling factors are site, soil, location, market, species present, their value and relative proportion, the degree of infestation, and the cost of labor. In many cases these factors combine in such a way that management is economically impossible." Apparently as much, if not more, assistance may be expected from the wilt disease and parasites as from forest management in controlling the gipsy moth. There seems reason to believe that eventually the moth will be reduced to a normal place among other injurious insects. A list of literature on the subject will be found in the appendix.

R. C. H.

PERIODICAL LITERATURE

FOREST GEOGRAPHY AND DESCRIPTION

Distribution of Jack Pine in Southeastern Minnesota

The coniferous forests of Minnesota occur to the northeast of a line drawn from near the northwestern corner of the State in a southeasterly direction to the boundary of Wisconsin at about latitude 45° 30′. This line shows a marked convexity toward the southwest, amounting to about 75 miles in its middle portion. Rosendahl and Butters, in a recent article, state that the original distribution of the three pines, *Pinus strobus, P. resinosa,* and *P. banksiana,* within the coniferous forest area was determined largely by soil conditions. Of these species the first is the one most capable of maintaining itself outside the evergreen forest area and of forming isolated outposts. These outposts of white pine are numerous, and for the most part consist of small groups of a few trees on rocky ledges of river bluffs, but occasionally of pure groves of an acre or more in extent. The authors state that to their knowledge there are about 30 of these isolated patches of white pine in southeastern Minnesota today, some consisting of but a few old trees, while others include younger trees and seedlings as well. Although many of these isolated patches of white pine occur 50 or more miles from the border of the coniferous forest area, the red pine and jack pine behave differently in their distribution. They rarely appear as isolated groups beyond the general area.

The red pine is not found beyond the general coniferous area except in the valley of the St. Croix River, where it forms outposts on the exposed Precambrian diabase of the river valley a few miles beyond the general border of the evergreen forest area.

Although the jack pine with the white pine form the skirmish line along the evergreen forest area across the entire State, the known outposts of the former were confined to three stations, all less than 15 miles from the general coniferous border until 1915, when a grove near Rushford was located about 120 miles from its previously known limit in Minnesota and some 50 miles southwest of the nearest place where jack pine is known to occur in Wisconsin. This isolated grove is confined to a limited area of disintegrating Paleozoic sandstone, so that the soil is very similar to that of the typical jack-pine country of north-central Minnesota and central Wisconsin. A considerable part of the grove, which is several acres in extent, is nearly pure jack pine, while the remainder is a mixed stand of pine and hardwoods.

It is believed by the authors that the above is a natural patch of jack pine which has succeeded in maintaining its existence in all probability since Glacial times. The presence of this grove, as well as the numerous groves of white pine in southeastern Minnesota, is explained in that they are relics of a former general distribution of pine forests throughout this area of the State. It is believed that this part of the State which is now within the general deciduous forest area was evergreen forest during the later Glacial periods. The subsequent disappearance of most of the pine is ascribed to a number of causes, of which climatic changes and fire are particularly emphasized. That there are so few relics left is explained on the theory that fires and increased competition with deciduous species caused their elimination except on particularly favorable soils.

J. W. T.

On the Occurrence of Pinus Banksiana in Southeastern Minnesota. The Plant World, Vol. XXI, No. 5, p. 107, May, 1918.

Japan's Hardwood Industry

The hardwood forests of Japan produce an excellent quality of oak, ash, birch, beech, and a few other hardwoods. Oak constitutes the principal export of lumber from Japan, though a little ash (tamo and sen) and birch is also exported. All of the softwood produced in Japan is used locally. Larger sizes of softwoods are imported from the United States. Large forests of beech remain unexploited, though the rapid expansion of Japan's hardwood industry is anticipated, due to the increasing number of furniture, veneer, barrel, and other wood-working factories that are coming into Japan. Prices for hardwoods are from 10 per cent to 15 per cent lower than prices prevailing on the Pacific coast of the United States for similar material.

B. L. G.

Japan's Production of Hard and Soft Wood. Eastern Commerce, January, 1918, pp. 34-35.

BOTANY AND ZOOLOGY

Determination of Wilting in Plants

In 1912 Briggs and Shantz defined permanent wilting in plants as attained when they do not recover their turgidity in a period of 24 hours when surrounded by air saturated with water vapor. Bakke has recently used standardized hygrometric paper in determining the extent of wilting and the permanent wilting point in studies on the water relations of plants. From the results of investigations extending over two seasons, the author concludes that the transpiring power of plants as determined by standardized hygrometric paper gives an accurate knowledge of the internal water relations of a plant. The exact wilting point as determined by this method occurs when there is a serious rupture in the water columns. A high evaporation gives an increased transpiring power, but during the process of wilting the index of foliar transpiring power comes to be independent of evaporation. Older leaves wilt long before younger ones and the time interval varies with age.

J. W. T.

Determination of Wilting. The Botanical Gazette, Vol. LXVI, August, 1918, p. 81.

Japanese Larch

Japanese larch (*Larix leptolepis*) has been planted to a limited extent in eastern United States, where, in its juvenile stage, it makes a remarkably rapid growth. In England and elsewhere on the continent of Europe it has been planted much more extensively, and observations on the species there should be of interest to those who have planted this species in the United States. H. R. Beevor describes his experience with the tree in England since 1901. For nine successive years he planted from three to four acres each year, either pure or in various mixed stands with other conifers or with hardwoods.

In early youth the Japanese larch in England, according to the author's experience, exhibits the following characteristics:

1. Where the tree thrives it dominates the European larch and common hardwoods strongly.
2. It is more susceptible to drought than other trees.
3. It grows well on ground kept clean, but does not usually make headway in the simple pitting of recently felled plantations.

It is much more tolerant than the native larch. Its silviculture as regards dominance is very different from the latter species. At 11 years of age, when planted in mixture with European species, most of the latter were suppressed or killed by it. While the European larch is often grown as a nurse for other species, even beech will not survive in alternate rows with the Japanese species. The latter suffers much more than the former from severe drought and the competition occasioned by grass and other vegetation is much more fatal. In the writer's opinion, Japanese larch should be planted only on ground that can be kept clean or that retains considerable moisture in the surface layers of the soil during periods of prolonged drought.

Aside from its rapid juvenile growth, the advantage in planting Japanese larch in England is its freedom from disease. So far as experience goes, the writer states that when grown successfully it will be a most profitable crop to cut at an early age and perhaps to 40 years, and there is no evidence against its giving good success to a greater age.

Although the reviewer has little faith in the extensive use of exotics for use in forest planting in eastern United States, from the fact that Japanese trees as a whole are better adapted for growing in eastern United States than species from western Europe, the Japanese larch should be more acceptable than the European larch, which has been planted in many places in this country.

J. W. T.

Japanese Larch at Hargham. Quarterly Journal of Forestry. London, April, 1918, p. 117.

Philippine Dipterocarpaceæ

Foxworthy has brought together in classified form our present knowledge of the Philippine Dipterocarps. The importance of this large group in tropical forestry makes the paper under review one of particular interest to foresters and dendrologists working in tropical regions or interested in tropical forestry. A synopsis of the Philippine species, published but six years prior to the present paper, recognized 48 species as occurring in the Archipelago. Since then the recognized species has been increased to 70. Common names seldom apply to a single species, but usually to a group of species, often a dozen or more species being designated by the same common name.

A list is given of the commercial woods of the entire group by their names in the principal markets, followed by all the species known to represent each name. In all, but 10 commercial or trade names are applied to the wood from the entire 70 species. Many new species are described; some are illustrated by line drawings. Keys have been rewritten for the different genera and extended so as to include the many heretofore undescribed species.

J. W. T.

Philippine Dipterocarpaceæ. The Philippine Journal of Science, Vol. XIII, Sec. C, No. 3, May, 1918, p. 163.

Germination of Cupressus torulosa Seed

The repeated failures of direct sowings of *Cupressus tortulosa* in India led to a series of experimental sowings by Bhola, carried out at Pauri (elevation about 6,000 feet), in the monsoon rains of 1917. The seeds were sown in pots after being subjected to the following four separate processes:

1. Soaking the seed in water for 24 hours before sowing.
2. Mixing the seed with cow-dung 24 hours before sowing.
3. Sowing without subjecting the seed to any process.
4. Keeping the seed for 3 minutes in boiling hot water before sowing.

All the pots were kept under similar conditions in the open, exposed fully to the effects of rain and sun.

The results obtained are tabulated below:

Process	Number of days required for germination	Percentage of germination
1	12	69
2	10	66
3	12	70
4	15	2

It appears from the above that processes 1 and 2 had but little effect upon germination as compared with sowings without previous treatment of the seed. On the other hand, the adverse effect of boiling hot water on the vitality of the seed is apparent. The reviewer's experience in subjecting various species of tree seeds to boiling water prior to sowing have given similar disastrous results. The viability of all species of tree seeds suffers from boiling hot water when the seeds are submerged in it over-long. How long they will survive depends upon the character of the coverings over the seed and the size and character of the seed itself. The seeds of the honey locust and the Kentucky coffee tree are killed when placed in boiling water for a period of 3 to 5 minutes, although germination is accelerated when the seeds are submerged in water but a few degrees below the boiling point until they have swollen to two or three times their normal size.

At the same time that the Cupressus seeds were sown in pots (at the beginning of the monsoon rains) seeds were sown in nursery beds and in patches made in well prepared soil in the forest. In both cases germination took place in two or three weeks after sowing, due to the constant soaking the seed received from the heavy and continuous monsoon rains of 1917. In 1916 germination did not take place until October, and seeds sown in the forest in the winter of 1915-16 resulted in almost complete failure on account of scanty rains. The investigation indicates that successful germination of cypress does not depend upon the method of treatment of the seed prior to sowing, but both in direct sowing and nursery practice the seed should be sown so that it may have all of the wet season before it in which to germinate. Winter sowings generally result in failure.

J. W. T.

Indian Forester, April, 1918, p. 175.

UTILIZATION, MARKET, AND TECHNOLOGY

Logging in Borneo

Under normal conditions British North Borneo produces annually about 1,700,000 cubic feet of timber, this timber practically dominating the Hongkong market. Though the density of the stands of timber and the topography of Borneo decidedly warrant the use of steam logging, hand logging is still in general use. The timber is bucked into 16 to 30 foot lengths, and about 70 per cent of the logs are also rough squared in the woods. The logs are rolled by hand to skid roads, loaded on crude sleds, and hauled by coolie labor to water or to railroads. Such railroads as are in use for logging have 16-pound rails and 6-ton locomotives. When the logs are rafted in the water, some skill must be exercised in building the rafts (which are small, consisting of from four to six logs), as about 50 per cent of the timber found in Borneo is heavier than water and it is necessary to provide floaters for the heavier species. The principal woods exported are seriah (Borneo cedar), billian (Borneo ironwood), kapor (Borneo camphor), kruin, and selangan batu. Seriah is similar to Philippine lauan. Billian is a satisfactory substitute for Australian jarrah. Kapor, which also produces a gum practically as valuable as the Formosa camphor, is an excellent substitute for teak in decking. Kruin is similar to Philippine apitong. Selangan batu is the species known in the Philippines as yacal.

B. L. G.

Logging in British Borneo. The Timber Trades Journal, LXXXIII, April 13, 1918, pp. 23.

Woods Used in Manufactures

Based upon the detail reports on wood-working industries in the various States, J. C. Nellis, formerly a forest examiner in the U. S. Forest Service, compiled an extensive table, giving the amounts of wood of various species used in the 53 cited manufactures of wood products. These do not include lath, shingles, cooperage, veneer, pulp distillation, poles, and ties.

We consider it worth while to enumerate the totals for each species, as this gives an indication of their relative need in wood-working industries:

Species.	Thousand feet b. m.	Species.	Thousand feet b. m.
Yellow pine	8,610,685	Mahogany	50,575
White pine	3,112,698	Spanish cedar	30,323
Douglas fir	2,273,788	Sycamore	26,052
Oak	1,983,584	Black walnut	23,988
Maple	919,420	Cherry	12,047
Spruce	805,050	White fir	11,338
Red gum	797,343	Willow	10,664
Hemlock	798,752	Dogwood	7,518
Yellow poplar	680,936	Noble fir	6,653
Cypress	668,353	Magnolia	6,156
Western yellow pine	563,816	Buckeye	5,486
Birch	481,293	Persimmon	3,571
Hickory	389,604	Cucumber	2,660
Basswood	369,640	Butternut	2,310
Cottonwood	322,642	Red alder	2,248
Chestnut	298,849	Circassian walnut	1,744
Ash	295,461	Lignumvitæ	952
Beech	278,203	Locust	639
Elm	218,200	Ebony	528
Tupelo	127,958	Rosewood	471
Redwood	122,326	Eucalyptus	338
Larch	114,029	Miscellaneous:	
Cedar	102,248	Foreign	8,451
Sugar pine	59,211	Native	4,447
Balsam fir	53,262		
		Total	24,576,510

St. Louis Lumberman, May 1, 1918, pp. 28-31.

Creosote-coal Tar on Paving Blocks

During the past few years there has been much discussion concerning the advisability of using a mixture or "solution" of coal tar and creosote in the treatment of paving blocks. The use of the mixture has been championed by Dr. Hermann von Schrenk, while P. C. Reilly, who is at the head of a large creosoting company at Indianapolis, Indiana, has been equally active in condemning the use of other than pure creosotes containing a large percentage of the higher boiling fractions. Reilly cites the experience of the city of Indianapolis with a pavement laid in 1909 on Washington

Boulevard. The blocks in this pavement were treated with 20 pounds of a creosote-coal tar solution per cubic foot. Extreme bleeding made the street impassable during the hot summer months in 1910, 1911, and 1912. In 1917 the "pop-ups" caused by excessive expansion became so numerous that the street became dangerous for traffic. This trouble is increasing every year.

Destruction of Wood Block Pavement Due to the Use of Tar in the Creosote Oil. P. C. Reilly, Municipal Engineering, LIV, May, 1918, pp. 183.

Water Absorption of Frozen Wood

In driving logs of spruce and balsam fir a certain number are invariably lost due to waterlogging. The Forest Products Laboratories of Canada have recently concluded a laboratory study to determine whether frozen logs will absorb more water and be more likely to sink than logs which are thawed before they go into the water. The conclusions drawn from the study are as follows: Frozen wood put into water will, until it has thawed, absorb more moisture than wood which is thawed before it goes into the water; but after the frozen wood has thawed in the water it will absorb less moisture than the wood which was not frozen when it was put in the water. The very small difference in the total moisture content indicates that whether or not logs are frozen when put into water has little effect upon the subsequent sinking of the logs.

B. L. G.

Absorption of Water by Frozen Green Wood as Compared with that of the Wet Green Wood. Pulp and Paper Magazine of Canada, XVI, April 25, 1918, pp. 379.

Rubber Production of the World

During recent years the production of wild rubber has markedly decreased, from 70,410 tons in 1913 to 52,258 tons in 1917, while the production of plantation rubber during the same period has increased from 28,518 tons to 204,251 tons. The present commercial rubber plantations are chiefly in the Malay Peninsula, which alone produces about one-third of all of the plantation rubber, and in the Dutch East Indies, Ceylon, India, Burma, and Borneo. The Far East now produces fully 80 per cent of the world's supply of crude rubber. It is believed that if the plantations in the Philippines were supported by capital as those of Malaya have been they would become an important factor in the future supply of rubber. In 1913, 50,000 tons of rubber were imported into the United States, 30 per cent coming from the United Kingdom, being transshipped from Europe. About 80 per cent of the raw-rubber supply of the world is controlled by interests in the United Kingdom. In 1917, the United States imported 180,000 tons of rubber, valued at $233,000,000. Of this amount, 19 per cent came from Europe, 62.5 per cent from Asia, 16 per cent from South America, and 2.5 per cent from North America. After the war it seems probable that the direct shipment of crude rubber to the United States will be much curtailed, as the principal competitors of the United States in the rubber manufacturing industries will be her present allies—the United Kingdom, France, and Italy.

B. L. G.

Rubber Trade of the World. Commercial America, XIV, May, 1918, pp. 19-25.

STATISTICS AND HISTORY

Swiss Forest Area

Even in such a small and thoroughly organized country as Switzerland, forest statistics are difficult to gather and interpret. From the reports of the federal bureau, it would appear that in the period from 1878 to 1916 the forest area of Switzerland has increased from 19 to 23.8 per cent, an increase of nearly 500,000 acres in 38 years. But this increase is only fictitious, for actual forest planting for protective purposes, with subventions by the federal government, in the 40 years from 1872 to 1912, increased the forest area hardly by 28,000 acres. The large increase in the figures is due to the inclusion of pastures and brushwood, which formerly were excluded, and in part, to be sure, due to closer survey. This statistical change accounted in the last year alone for over 150,000 acres.

All the detail statistics are changed accordingly, and we find now 4.3 per cent of State forest, 67.1 per cent of communal and corporation forest, and 28.6 per cent in private forest.

Journal Forestier Suisse, May, June, 1918, pp. 81-84.

POLITICS, EDUCATION, AND LEGISLATION

Practical Forest Management

Pleading for the need of keeping the technical staff of a State Forester's department in contact with practical commercial operations, the State Forester of Massachusetts, Mr. F. W. Rane, recites his method pursued in this respect in the last four years. It consisted in stirring up owners of woodlands that had been devastated by the gipsy and brown-tail moths and the chestnut blight to utilize the conglomeration of hardwood material of all sizes and ages to the best advantage.

A technical man with some practical training in the State Forester's department was set to study the situation and to find out market conditions and to solve the practical problem of utilization.

The statement is not very clear as to how the matter was arranged, but finally it appears that forest owners were induced to invest in portable mills and the costs are borne by them, the State Forester furnishing only the supervision and the education of the foreman, although it is stated that "every part of the operation to the sale and delivery of the product is looked after, even to reforesting or underplanting, until the whole operation is complete and the final account settled by the State," which would appear to involve expenditures for the State; but, he continues, "the only expense the State has been to is the expense of one assistant, who devotes his whole time to utilization. He spends only enough time on each operation to see that it is properly set up and is kept running economically. The success of the whole matter is in keeping costs low and in turning out forest products for which there is a demand at fair prices."

No details of the financial aspects are given; but it is stated that "during the past four and one-half years this work has resulted in our cutting approximately 6,800,000 board feet of lumber, 28,000 cords of wood, and over 25,000 ties and poles. When it is realized that little, if any, of this work would have been done had not the State Forester's department initiated and carried it through, it is believed to be well worth while."

Promoting Practical Forestry Work. Proceedings, Society for the Promotion of Agricultural Science, November 12 and 13, 1917, pp. 91-4.

EDITORIAL COMMENT

An interesting phase in the efforts to secure rational forest taxation took place in New Hampshire in early June, when the State Constitutional Convention met, and adjourned almost immediately until after the war, having had before it for discussion and vote only the one proposition of granting authority "to specially assess, rate and tax growing wood and timber without regard to the rule of proportion otherwise required in taxation."

The proposition was voted down by 159 against 122 votes, not a bad defeat, the desire for adjournment having probably some influence on the vote. It is significant that the resolution was introduced by a forester, Philip W. Ayres, of the Society for the Protection of New Hampshire Forests, who was elected as the only progressive delegate to the convention. The measure will come up again, probably with augmented strength, when the convention reassembles.

Among the campaign material used to make propaganda for the resolution, appeared an Extension Circular (No. 39) of the New Hampshire College, compiled by K. W. Woodward, entitled *Taxation of Woodlots,* which in a very convenient form brings together information regarding the influence of improper tax legislation on woodlots in the State, leading mostly to premature cutting, and on the practice and experience in forest taxation in other States. The latter is summarized as follows:

1. Most States have no constitutional limitation on the method of taxation.

2. Four important woodlot States, Connecticut, Massachusetts, New York, and Pennsylvania, have passed special laws providing for the payment of the greater part of the taxes when the timber is ready to cut. Michigan's law, while the same in principle, is hedged about with too many restrictions to be applicable except on a small scale.

3. Ten States exempt plantations or in some cases young growth, for periods varying from ten years to maturity. These States are Alabama, Iowa, Maine, Nebraska, New Hampshire, North Dakota, Rhode Island, Vermont, Washington, and Wisconsin.

4. Thirteen States have provided no special woodlot legislation because this is an unimportant interest for them. They are the plains, or prairie States, and include Arizona, Colorado, Illinois, Maryland, Kansas, Montana, Nevada, New Mexico, Ohio, South Dakota, Utah, and Wyoming.

5. In a group of seven Southeastern States, which includes Florida, Georgia, Louisiana, Mississippi, Oklahoma, South Carolina, and Texas, the growing of

timber is not yet considered worth while. The lands within their borders are flat and an attempt is being made to turn all cut-over land to tillage purposes.

6. The remaining nine States have no special legislation with reference to the taxation of woodlots because the timber holdings are mostly in large tracts and belong to lumber companies whose paramount interest is rapid exploitation. In many cases coal or other minerals are the main reason for holding the lands. Furthermore, most, if not all of them, have no constitutional limitation on the method of taxation so that the legislatures can quickly pass remedial legislation if it is found advisable.

A bibliography prepared by Miss Helen F. Stockbridge, Librarian of the U. S. Forest Service, is appended, containing over 250 titles.

"Strange Attempts"

Students of forest economics, and particularly those who have given much thought to such problems as the securing of continuity of production through increased public control or ownership of our forest resources, will be interested in the following extract from an article by Judge L. C. Boyle, published in the Monthly Bulletin of the National Lumber Manufacturers' Association for September 5, 1918, under the title "Unity and the National":

"The mere suggestion of this subhead (Legislation) indicates its importance. We are approaching an era of revolutionary changes. If this industry is to have its property interests safeguarded, it must with certainty act as a unit. Already the suggestion has emanated from high places that our natural resources should be placed in the hands of the whole people, and this for the common good. Of course, the Constitution of our country protects private property from confiscation. At the same time we may rest assured all kinds of *strange attempts* will be made to interfere with private control of our natural resources.

"Aside from all speculation, I personally believe that legislation will be passed amending the Sherman Law, whereby those handling Nature's resources will be given opportunity to agree on production problems, and this under governmental supervision. The industry is deeply concerned in this matter and should be united in expression."

Although the language is not particularly explicit, one gathers that Judge Boyle is inclined to look askance upon any attempt to interfere with private control of natural resources as confiscation of private property, and to oppose any governmental supervision except such as would permit greater freedom of combination among "those handling Nature's resources." Apparently he has no conception of the fundamental importance, not only from the standpoint of the general public, but of the lumber industry itself, of handling the forests, so as to keep them continually productive, and of the part which greater public control might play in accomplishing this. It is to be hoped that the industry as a whole takes a broader view of the matter. If not, it is not at all unlikely that "strange attempts" will indeed be made, as Judge Boyle fears, to improve present conditions in the interest of the common good.

A case of private forest management in Canada is reported by Garneau. It has reference to 84,000 acres of timberland belonging to the seignory of Lotbinière, half of which is under cutting rights of a lumber company, the other half under conservative management by the owner.

The latter, who secured his forestry education at the University of Toronto, is the grandson of Sir Henry Joly de Lotbinière, one of Canada's most noted citizens and earliest and most vigorous forestry propagandists, also for years vice-president of the American Forestry Association, and known for his walnut plantations, semi-successful in the inhospitable climate of Quebec. He it was who began the practice of conservative lumbering on his extensive estate, and the grandson worthily has improved on his methods. The 44,000 acres under present management contain merchantable material of 17,515 feet per acre on the average. It is not clear how the cut is gauged, except that the percentage of hemlock cut is 20 per cent, and that of spruce and balsam 70 per cent of the total, while in the stand hemlock participates with 10,000 feet and the other two conifers with 6,000 feet, a clear disproportion in the cut.

The main point in the management, which silviculturally relies upon the selection system, is a systematic subdivision (with an unfortunate mixing of nomenclature) into compartments, called divisions, and into lots of one square mile, called compartments "for scientific calculation and orientation"; these, again, are subdivided into logging chances, called working blocks, for letting to jobbers. The trees to be cut are marked from silvicultural considerations, and, of course, all waste avoided and protection organized under a superintendent of fires. Since the organization comprises, besides an administrator and mill manager (the service operates its own mill), a forest engineer, with two assistants, the chances of a successful management from the standpoint of personnel are good. There is no financial statement given.

NOTES

Our attention is called to an error in the note on page 625 of this volume regarding the election of Messrs. Graves and Sargent to honorary membership in the Scottish Arboricultural Society as the only citizens of the United States who have received that honor. At the time Mr. Graves was elected the same honor was conferred on E. C. Hirst, State Forester of New Hampshire. Mr. Hirst is in charge of a battery of ten sawmills in Scotland, logging for the British army, as one of the units of U. S. Forest Engineers.

How American Foresters Can Help France

The Forest Service, through the State Department, has recently been requested by the French Minister of Foreign Affairs to supply the French Government with about 200 pounds of Douglas-fir seed and 500 pounds of eastern white-pine seed. The Forest Service will probably be able to take care of the Douglas-fir seed, at least in part; it cannot, however, furnish the seed of eastern white pine. The co-operation of State forest organizations is therefore very much desired. The State of Minnesota, through the Cloquet Experiment Station, has already offered 200 pounds of white-pine seed and the State of Vermont, through its State Forester, 50 pounds. The State Forestry Commissioner of Pennsylvania has agreed to furnish the French Government 2,500,000 white-pine seedlings. Any additional proffers of seed will be much appreciated by the Forest Service, and still more, I am sure, by the French Government. This is one effective method which United States foresters can follow in assisting France to reclaim areas devastated by the war.

H. S. Graves.

Due to difficulty in securing newspaper material, the War Industries Board has ruled that during the war no new newspaper shall be established, and existing daily papers, since August 12, have been obliged to reduce their paper consumption 15 per cent; Sunday editions, since September 1, 20 per cent.

On page 632, Vol. XVI, No. 5, Journal of Forestry, reference is made to the killing of trees in India with Atlas preservative. John

Foley informs us that the base of its composition is arsenic, and that Atlas A is used by railroads in the U. S. A. as a track weedicide. One interested in the chemical can write for particulars to Chipman Chemical Engineering Company, Liberty street, New York, N. Y.

Rock Elm

The following notes were made by E. H. Frothingham during a recent trip into northern Shawano and southern Langlade counties, Wis.:

There has been some doubt as to whether the commercial rock elm was identical with the true rock elm or cork elm (*Ulmus racemosa*); it has been suggested that most of it was simply a dense wooded form of the white elm (*Ulmus Americana*). It would seem that the latter suggestion is the more nearly correct; but this dense wooded form of elm has characteristics which entitle it to recognition as distinct from white elm, or at least from the commercial "soft elm."

On this trip I talked with Mr. Louis Kemnitz, who has had large experience in getting out rock elm timbers for the British Government, and with Mr. Peter O'Connor, woods foreman for the Yawkey-Bissell Lumber Co., who has had a long term of service in the woods in this region. I went into the woods on the Menominee Indian Reservation with Mr. Kinney, of the Indian Forest Service, and was shown standing "rock elm" trees and the slash from trees which had been cut and logged out by Kemnitz. In the Yawkey-Bissell holdings near White Lake, Langlade county, Mr. O'Connor showed me logs and timber of both "rock" elm and "soft" elm, and pointed out the difference between them. None of the trees I saw had the characteristic corky twigs of *Ulmus racemosa*.

Mr. O'Connor identified my description of cork elm with what he called the "shaggy twig elm," or "river elm," and said that this elm was formerly much used for cant hooks and axe handles because of its toughness. He said that this tree is entirely distinct from "rock elm." It is smaller, both in height and diameter ("a river elm is pretty good sized when over a foot in diameter"), and tapers more at the top. It is even smaller than slippery elm. It is found on river flats. There is considerable of it around Wausau, and he has seen some on the Wolf River, near New London, but there is none, or practically none, in the region under discussion (Shawano and Langlade counties), which is said to be the best "rock elm" territory in Wisconsin. When "rock" elm is referred to in the following notes, therefore, it is undoubtedly not cork elm (*Ulmus racemosa*).

As pointed out to me by Mr. O'Connor, the "genuine rock" elm can be readily told from "soft" elm by the bark and by the checking of the log ends after felling. The bark is in thicker ridges, which are more pronounced, deeply cut, and continuous than those of soft elm bark. Soft elm logs nearly always show ring shake and little checking, while rock elm logs are rarely shaky, but usually have plenty of radial season checks. This difference is remarkably consistent with the difference in character of bark.

The trees apparently differ in branching habit. "Soft elm" characteristically sends up large branches almost vertically from the point where the crown breaks. "Rock elm" does not seem to have this characteristic—at least to such a pronounced degree.

The trees are probably equally tall. The "soft elm" has a more rapid taper, a shorter stem, and a heavier top than "rock elm." "Rock elm" is most abundant and well developed on high, stony ground; "soft elm" in low places; but some trees of "rock elm" are found on lower situations and some "soft elm" on high, stony ground. When "soft elm" is found on higher ground, however, it is apt to be short and swell-butted, in contrast to the longer-bodied "rock elm." Mr. O'Connor stated it as his belief that "soft elm" becomes swell-butted through the freezing of the large amount of water held in the pores.

"Rock elm" is straight grained and splits easier than "soft elm." In falling "rock elm" the heart must be almost entirely cut through in notching, or the tree will split clear to the top. This straightness of grain and ease of splitting was demonstrated when the special order of "rock elm" was sawn for the Curtis Company; heart planks would sometimes split through the center from end to end when dropped from the saw.

Cruisers apparently have no difficulty in selecting the more typical "rock" and "soft" elms, but they speak of "hybrids" between the two which are inferior to "genuine" "rock" elm. In most cases, however, distinction is plain. It was perfectly easy for Mr. O'Connor to select the trees for the special order of "rock" elm lumber ordered by the Curtis Company.

The lumber of the two kinds is quite different in appearance. "Soft" elm lumber has a slight resemblance to ash, the pores being quite pronounced on tangential section. "Rock" elm lumber, on the other hand, has a more even texture, the pores not being so evident.

While this "rock elm" is probably not *Ulmus racemosa*, it is very possibly the kind from which the specimens of "rock elm from Wisconsin" were obtained for the Forest Products Laboratory. If this is the case, the strength tests there made are indicative of commercial "rock elm," and not of the botanical "rock" or "cork" elm (*Ulmus racemosa*). It would be well to ascertain whether samples of twigs were sent along with the wood specimens tested.

Sand Bags of Paper

H. R. Christie, formerly of the British Columbia Forest Service, has sent to an Ottawa friend a sample of the German sand bags made entirely of paper fibers. In appearance the article somewhat resembles a coarse, brown linen bag, but is smoother in finish, each strand being tightly rolled and woven with great exactness. Mr. Christie states that the bags are very serviceable except when exposed to moisture, when they rot. The Germans, he reports, do not use nearly as many sand bags as the British and French, for the reason that they have more timber at their disposal and make prolific use of it.—Extract from Canadian Forestry Journal, September, 1917, p. 1300.

The Younglove Log Rule

In "Forestry Quarterly," Vol. XII, No. 3, there is an article by Mr. W. W. Colton on the Younglove log rule, in which he gives a history of this log rule, at one time widely used in Massachusetts, but now little known. He states that the basis of this rule is unknown, but believed to be based on a mathematical formula checked up by mill studies. He states that since the death of the inventor, Tyler Younglove, no more calipers have been made, and that the pair which he purchased in a Fitchburg (Mass.) hardware store was probably the last pair on sale.

The writer has just purchased a caliper rule made by a Mr. Laurence Watts, of Melrose, Mass., which he claims is the Younglove rule. Comparing this rule with the Massachusetts and Margolin log rules, it is found to resemble them very closely, and it is evident that it is for use under the same conditions, namely, for pine logs sawed into round-edge box lumber with a small percentage of square-edge material. The "Massachusetts" scale is a mill tally log rule constructed from data collected by the Massachusetts forestry department at portable sawmills in different sections of the State. The "Margolin" rule is a similar scale constructed from data collected by Margolin and Lyford in southern New Hampshire and published in the report of the New Hampshire

Forestry Commission for 1905-06. The Younglove rule is to be used "outside" the bark at a point one-third the length of the log from the small end or "inside" the bark at the middle—a curious condition. This will account for the slightly large figures given by the Younglove rule. It would therefore appear that the Younglove rule is a reliable scale to use under the lumbering conditions prevailing in southern New England, and the fact that it is still being made and sold makes it worth more than a historical curiosity.

"Massachusetts" and Younglove Log Scales Compared

12-foot logs

Diameter at middle	Younglove	Massachusetts	Margolin
6	18	16	13
7	21	20	19
8	30	26	27
9	37	33	34
10	46	41	43
11	56	51	53
12	68	62	64
13	79	73	76
14	91	85	88
15	103	99	104
16	119	116	119
17	137	132	136
18	154	148	155
19	172	166	173
20	189	185	193
21	208	204	211

H. O. Cook,
Assistant Forester, Massachusetts.

Specifications for Cross-ties

The United States Railroad Administration has announced new uniform specifications for cross-ties for all American railroads as follows:

Before manufacturing ties, producers should ascertain from the railroad to which they contemplate delivering them just which of the following kind of wood suitable for cross-ties will be accepted: Ash, beech, birch, catalpa, cedar, cherry, chestnut, cypress, elm, fir, gum, hackberry, hemlock, hickory, larch, locust, maple, mulberry, oak, pine, redwood, sassafras, spruce, sycamore, and walnut. Others will not be accepted, unless specially ordered.

Quality.—All ties shall be free from any defects that may impair their strength or durability as cross ties, such as decay, splits, shakes or large or numerous holes or knots. Ties from needle-leaved trees shall be of compact wood, with not less than one-third summer wood when averaging five or more rings of annual growth per inch, or with not less than one-half summer wood in fewer rings, measured along any radius from the pith to the top of the tie. Ties of coarse wood, with fewer rings or less summer wood, will be accepted when specially ordered. Ties from needle-leaved trees for use without preservative treatment and which shall not have sapwood more than two inches wide on the top of the tie between 20 and 40 inches from the middle will be designated as "heart" ties. Those with more sapwood will be designated as "sap" ties.

Manufactured.—Ties ought to be made from trees which have been felled not longer than one month. All ties shall be straight, well manufactured, cut square at the ends, have top and bottom parallel and have bark entirely removed.

Before manufacturing ties, producers should ascertain from the railroad to which they contemplate delivering them just which of the following lengths, shapes and sizes will be accepted:

All ties shall be 8 feet or 8 feet 6 inches long. All ties shall measure as follows: Throughout both sections between 20 and 40 inches from the middle of the ties:

Grade	*Ties sawed or hewed top and bottom sides*		*Sawed or hewed top and bottom*
1—			6 in. face 6 in. th.
2—	7 in. face 6 in. th.		7 in. face 6 in. th.
3—	6 in. face 6 in. th.		8 in. face 6 in. th.
		or	7 in. face 7 in. th.
4—	8 in. face 7 in. th.		8 in. face 7 in. th.
5—	9 in. face 7 in. th.		9 in. face 7 in. th.

The above are minimum dimensions.

Ties over one inch more in thickness, or over three inches more in width or over two inches more in length will be degraded or rejected. The top of the tie is the plane farthest away from the pith of the tree, whether or not the pith is present in the tie.

All ties ought to be delivered to a railroad within a month after being made. Ties delivered on the premises of the railroad shall be stacked not less than 10 feet from the nearest rail of any track at suitable and convenient places; but not at public crossings, nor where they will interfere with the views of trainmen nor of people approaching the railroad.

Ties should be stacked in alternate layers of two and seven, the bottom layer to consist of two ties kept at least 6 inches above the ground, the second layer to consist of two ties kept at least 6 inches above the first layer. When the ties are rectangular, the two outside ties of the layers of seven and the layers of two shall be laid on edge. The ties in layers of two shall be laid at the extreme ends of the ties in the layers of sevens. No stack may be more than 12 layers high, and there shall be 5 feet between stacks to facilitate inspection.

Ties may be ranked like cordwood, in which case the owner shall rehandle them while inspection is being made.

Ties which have stood on their ends on the ground will be rejected.

All ties are at the owner's risk until accepted. All rejected ties shall be removed within one month after inspection.

Ties shall be piled as grouped below. Only the kinds of wood named in the same column may be piled together.

Class U

Ties Which May Be Used Untreaated

Groups

UA—Black locust, white oak, black walnut.
UB—Heart pine, heart Douglas fir.
UC—Heart cedar, heart cypress, redwood.
UD—Catalpa, chestnut, red mulberry, sassafras.

Class T

Ties Which Should Be Treated

TA—Ashes, hickories, honey locust, red oaks.
TB—Sap cedars, sap cypress, sap Douglas fir, hemlocks, larches, sap pines.
TC—Beech, birches, cherry, gums, hard maples.
TD—Elms, hackberry, soft maples, spruce, sycamore, white walnut.

Shipment.—Ties shall be separated in the car according to the above groups and sizes as far as practicable.

Approved: Washington, D. C., June 11, 1918.

(Sgd.) JOHN SKELTON WILLIAMS,
Director of Finance and Purchases.
C. R. GRAY,
Director of Operation.

These specifications resulted from the work of regional committees which held meetings throughout the country and formulated recommendations. This is the first tie specification, embracing ideas of engineers and ties trade, and by radical reduction in number of grades and standardization of all tie production is expected to have a marked stabilizing influence on business.

Formerly on eastern roads hardwood ties of grades three, four and five were bought at one price. Under this specification proportional prices will prevail on various sizes, to the benefit of tie-producers. Specification is in the interest of conservation also, providing for all sizes so as to eliminate waste.

GROWTH OF WESTERN WHITE PINE AND ASSOCIATED SPECIES IN NORTHERN IDAHO

During the summer of 1912 a great many sample plots were laid out on and in the vicinity of the Experimental Forest at Priest River Forest Experiment Station in Northern Idaho. The purpose of this work was to obtain data on growth and yield of western white pine in general and for this region in particular.

In the fall of 1910 five of the plots which were thought fairly representative of the 50-year-old timber in different kinds of stands were remeasured and four years' growth figured. This growth, which is the first actually obtained by measurements of standing timber in this region, is shown in a condensed form in the following table:

Growth of Western White Pine and Associated Species

Chief species.	Per cent by chief species.	Total trees per acre, 1916.	Board feet per acre, 1916.	Current annual growth per acre, Board feet.	Number of years to double present volume.
White pine.........	89	1,540	12,025	1,095	11
Yellow pine.........	64	439	19,234	745	14
Douglas fir.........	56	948	7,342	879	8
Western larch......	82	1,164	6,982	393	18

The most significant thing brought out by these figures is the remarkable growth of the white pine, which in this instance adds 1,095 board feet per acre each year. This is followed closely by Douglas fir with a growth of 879 board feet and yellow pine with 745 board feet. In this region the precipitation is about 30 inches, which is about the average for the Idaho white pine region.

The data show an actual increase of 9.1 per cent for the white pine, 7.2 per cent for the yellow pine, 11.9 for the Douglas fir, and 5.6 per cent for the larch, and this is their present annual increase in value. The larch is not representative of the best growth of this species, for the soil on this plot was rather poor.

J. A. LARSEN.

Indian Forester, March, 1918, pp. 138-140, brings the following details about Balsa wood (*Ochroma lagopus*), which should prove of interest to American foresters, since the tree grows freely in the Central American States:

The structure of the wood is altogether special; it is composed of very thin-walled cells of barrel shape, which interlace with each other and contain scarcely any woody fiber; these cells are filled with air, and hence are derived both the extreme lightness of the wood and its property of non-conductivity of heat. Its weight, when thoroughly dried, is 7.3 pounds per cubic foot, cork, which stands next in lightness, weighing 13.7 pounds per cubic foot. It is not easily obtained in a dry condition, however, and therefore, as obtained commercially, it will be found to weigh from 8 to 13 pounds. And though so light, it has remarkable strength comparatively and great elasticity. The cells, which are parallel to the axis of the tree, are made up principally of woody fiber; those which extend in a radial direction usually have a cellulose structure with little woody fiber, and are defined as "medullary rays," or pith cells. The annual concentric rings show very feebly. The difference between balsa wood and cork lies in the circumstance that the first has interlacing fibers around the cellular structure; the latter has none, but the place of the fibers is taken by a resinous deposit which gives it no structural strength. This resinous deposit can be collected by means of pressure and heat to make what is known as cork board, which is put on the market in blocks 2 or 3 inches thick and from 2 to 6 feet long, convenient for use as a lining in cold storage or other structures.

Tests show compressive strength of balsa wood to average 2,225 pounds per square inch, about one-half the strength of white pine or spruce; also "the modulus of rupture to be approximately one-half that of good spruce. The uniformity of tests clearly shows that the material may be relied upon both for direct compression and for transverse loads." Its elasticity is demonstrated by the fact that beams bent almost to the breaking point have resumed their original shape upon release. It is practically impossible to split the wood by driving nails into it.

Heat transmission through balsa wood, though not much higher than for cork, is considerably lower than through white pine, and very considerably lower than through zinc.

Balsa wood is a rapid grower, attaining a diameter of 12 to 14 inches at an age of 4 to 5 years, when it may be from 40 to 60 feet high. The leaves vary in length from 14 to 30 inches. Its seed pods yield a woolly fiber suitable for pillows and mattresses. The tree is found in virgin forest only as an isolated tree in clearings, it being most commonly found as a second-growth tree.

The *Michigan Agricultural College Forester,* the annual of the Forestry Club for 1918, contains an interesting comparison by Professor Chittenden of the financial results of two woodlots belonging to the college, the one being managed for fuel, the other for maple syrup.

The fuel lot of 74 acres, with a growing stock of 2,369 cubic feet, or 26 standard cords per average acre, produces at the rate of nearly 2 cords per acre (178.5 cubic feet), an unusually large production. The selling price being $12 for the standard cord, or $4 for the 16-inch cord delivered, the cost of cutting this, $1.25, of hauling, 75 cents, leaves $2 per cord stumpage and margin, and, since the woodlot is growing at the rate of six 16-inch cords, the net returns per acre are $12. Instead of now relating the income represented by increment to the value of the growing stock of 26 standard cords, which would make the interest rate something like 1¼ per cent, the author assumes a value of $200, giving 6 per cent interest.

The 55-acre sugar bush woodlot, on which about 550 trees are tapped, making 160 gallons of syrup at $2, or less than $6, per acre gross, since the cost was $195.75, leaves a net profit of only $2.26 (23 cents per tree). It is stated, however, that this is not an "ideal sugar bush." In addition, wood resulting from thinnings, one 16-inch cord per acre, nets an additional $2, so that if 6 per cent is demanded the value of the lot would figure $71 per acre, or only about one-third of the fuel lot. No data are given to ascertain the actual value of the growing stock of the sugar bush.

The cost of sugaring is given as follows:

Tapping	$10.38
Gathering sap	69.80
Boiling sap	31.42
Taking up buckets	4.75
Wood	35.40
Containers	24.00
Depreciation on plant	20.00
Total	$195.75

Professor I. W. Bailey, of the Bussey Institution for Research in Applied Biology, has been given leave of absence by Harvard University and has accepted a position in the Materials Engineering Department, Bureau of Aircraft Production, Dayton, Ohio.

Last year's field planting at the Fort Valley Experiment Station, which, due largely to the favorable spring and foresummer, made a very good start, suffered severely from drought during the fall and early winter. The summer rains were unusually light, being practically over by August 5, while normally they continue throughout August. October, November, and December yielded only a trace of precipitation, while normally the total for this period is between 3 and 4 inches. Large numbers of plants which made a vigorous growth in July were dead or dying by January 1. By November 13 the percentage of survival had fallen from 90 to 73. No count has been made this spring, but the percentage is probably not above 50. In this connection it is interesting to note the mortality among natural seedlings. Five plots of second-year seedlings were laid out in July, 1917. Each seedling was marked with a wire pin and a numbered tag. Taking the number of thrifty plants at the time the plots were established as 100 per cent, the percentage of survival on November 27 ranged from 61.1 to 83, and on May 7, 1918, from 16.6 to 62.1.

A shortage of feed-stuffs has led English farmers to the use of acorns for stock and the following experiments are reported:

For the first two weeks the ration for agricultural horses consisted of 3 stones of acorns, 1 stone of maize, and 2 stones of bran per horse per week. Then, owing to the shortage of maize, 2 stones of palm kernel cake were substituted for the maize ration. During the winter it is proposed to replace the palm kernel cake by 1 stone of ground nut cake and 1 stone of fish meal. The farmer writes:

"This may be considered by many to be an inadequate food, yet our horses are making full days and working hard, ploughing and dragging timber, etc. In addition, they have straw chaff and 1 stone of hay per horse per day. They look well and the acorns have not shown bad effect. Should signs of constipation appear each horse would be given 1 pint of linseed each week, the linseed being previously soaked until it forms a jelly."

As regards the method of storing and grinding the acorns, the following particulars are given:

"Acorns when stored in the granaries should be moved every two to four days, and perhaps oftener if the weather is damp and mild. There is some difficulty in getting this properly and conscientiously done. On their first arrival the acorns may be scattered, say, 1 inch thick on the floor, and afterward shovelled, or moved with a large wooden hoe, into long lines across the building, the depth of them being in accordance with dryness and space; this ensures that the lines are turned quite over and the lower acorns brought to the top.

"It is desirable that these lines should always be moved in the same direction if possible, the wet ones coming in at one end of the building and passing out to be ground up from the other end; in this way the moving and turning of every acorn is more assured.

"It is most important that the acorns should be thoroughly dried before being ground; they should also be sifted so as to extract all dust and grit.

"They can be ground satisfactorily by the ordinary grist mill driven by a farm threshing engine, and no doubt also by an oil engine of similar power.

"When quite dry, the acorns can be ground as fine as barley or maize meal, as by so doing the shell becomes slightly more digestible, but this cannot be done without admixture with some drier ingredient such as maize, palm kernel, or ground nut cake. It might be possible to grind them alone if they have been kiln dried, but this is quite unnecessary. If the nuts are too large, or the cake requires it, they can, of course, be passed through the cake-breaker.

"The grinding is rather a slow process, and the cost works out about 2*s.* 9*d.* per coomb or sack. The cost of collection is 4*s.* per sack, and of carting and turning 1*s.* 3*d.*, so that the total cost is 8*s.* per sack.

"It is important that the food, as soon as it comes from the mill should be mixed with the bran; this dries it, and prevents heating. It should immediately be spread over the granary floor, say, 3 inches deep, and turned every day. The rations should be served to the horsemen from the granary every day, as otherwise it would probably be carelessly stored by them and then would certainly heat and spoil."

A Canadian inventor has solved the problem of burning green wood in logging operations, both in yarders and locomotives. It consists of a machine to create a forced draft. The nose of the machine is introduced into the fire-door opening of existing steam boilers, and operations start at once. Six stationary plants are already built in British Columbia carrying out this principle—burning green wood.

The Canadian Forestry Association this summer adopted the modern way of making propaganda by outfitting a traveling exhibition car with instructive objects and educational photographs. Motion pictures and lectures formed part of the attraction. The main object was to create public interest in fire protection.

Cordwood is to be cut by the War Department on the Pisgah National Forest at the rate of 500 cords per day. A labor battalion of 1,200 negro soldiers is now camped in the forest and ready for work, which will be begun as soon as the officers in charge get their bearings, and also the proper equipment with which to do the work. Shipment of the wood will be over the Car Lumber Company's railroad, which at present is used to its capacity in transporting tanning material for the War Industries Board.

The Minnesota Station has issued a bulletin (No. 168) which gives data on soil requirements, growth, yield, and distribution of white spruce, together with approximate returns which may be expected from young seedlings or plantations. Suggestions are made regarding the possibilities of private investment and a rational system of taxing forest land. The main features of the Massachusetts forest taxation law are quoted.

SOCIETY AFFAIRS

Meeting of the Society of American Foresters at Baltimore, Md.

The Society of American Foresters will meet in conjunction with the Association for the Advancement of Science, at Baltimore, December 27 and 28. The program, so far as it has been at present completed, is shown below:

Forest Problems of Europe. Col. H. S. Graves.
Silvicultural Problems in Eastern Pulpwood Forests. Dr. B. E. Fernow.
Forest Research and War. E. H. Clapp.
The Timber Census in the Northeastern States. Prof. A. B. Recknagel.
Gray Birch and White Pine Reproduction. Prof. J. W. Toumey.
A Forest Policy for Louisiana. R. D. Forbes.
The Effects of Destructive Lumbering on Labor. Prof. B. P. Kirkland.
Factors Controlling the Distribution of Forest Trees in Arizona. G. A. Pearson.
Some Remarks on State Forest Policies. Prof. R. S. Hosmer.
The Logged-off Land Problem as a Part of the Reconstruction Program After the War. R. Zon.
Some Aspects of Silvical Investigation as a War-time Activity. C. Leavitt.
The New England Campaign to Stimulate the Production and Use of Wood for Fuel as a War Measure. Prof. W. D. Clark.
Marketing of Timber from Farm Woodlands. F. W. Besley.
Preliminary Results of Forest Experiments in Pennsylvania. Prof. J. S. Illick.
Some Future Possibilities in the Forest Industries. Prof. F. F. Moon.
The Lumber Industry and Its Relation to the War Program. Prof. R. C. Bryant.
War Lumbering in Scotland—Some Suggestions for American Forest Policy. E. C. Hirst.
Subject to be announced later. Prof. G. C. Morebeck.

The annual business meeting of the Society will also be held at the same time, and the annual reports of the various officers will be presented.

The War Committee of the Society of American Foresters

Since early spring the Society's committee, in co-operation with the U. S. Forest Service, the State foresters, State forestry associations, and other agencies, has been engaged in a timber census of the New England States and New York. In April, A. B. Recknagel, forester for the Empire State Forest Products Association, R. S. Kellogg, secretary of the News-Print Service Bureau, and F. H. Colby, forest commissioner of Maine, initiated a plan to ascertain the remaining timber supply of New York and New England, particularly spruce, through the active efforts of the War Committee of the Society of American Foresters.

Early in May statistical cards were printed to send out to timberland owners in New York and Maine, and arrangements made for Recknagel to collect the statistical information in New York, and Colby in Maine.

The chairman of the War Committee undertook to find foresters and others in Rhode Island, Massachusetts, Connecticut, New Hampshire, and Vermont to undertake the work of distributing suitably prepared statistical blanks in their respective States to be filled out by the timberland owners. State Foresters Mowry in Rhode Island, A. B. Hastings in New Hampshire, and W. G. Hastings in Vermont, the chairman of the War Committee in Connecticut, and H. A. Reynolds, secretary of the Massachusetts States Forestry Association, accepted the task of distributing the statistical cards in their respective States and the tabulation of the data. The work was extended in New York in co-operation with the Conservation Commission.

The importance of a comprehensive timber census for New York and New England, particularly for the purposes of determining timber of various kinds suitable for war needs, brought about co-operation with the U. S. Forest Service, and Kenneth M. Clark, of that Service, after conference with the chairman of the War Committee and those co-operating in the gathering of the statistical data, arranged for material aid in the furthering of the enterprise.

The first task in each State was the securing of a list of the owners of merchantable standing timber by towns. In most States the compilation of an acceptable list was made possible by co-operation with the office of the State Tax Commissioner and through him with the local assessors.

The aim is to adopt a uniform method in working up the data from all the States. The work of collecting the data is already completed in some States; in others it is well under way. In only one or two States has the work lagged and not met the expectations of the War Committee of the Society.

J. W. Toumey,
Chairman.

Program of Meetings Held by Intermountain Section

The Intermountain Section held its second series of meetings during the winter of 1917-18. While the attendance was not large, averaging from 15 to 30, considerable interest was manifested at the meetings, at which the following subjects were discussed:

December 12:

Synopsis of Grazing Studies Work at the Great Basin Experiment Station, by A. W. Sampson.
Discussion of Grazing Studies Work in War Time, by J. T. Jardine.

January 23:

Systematization of Range Inspection by Use of a Manual, by Mark Anderson.
Grazing Working Plans, by L. J. Palmer.
Forest Road Work, by T. W. Norcross and A. E. Loder.

February 13:

Fire Co-operation in Idaho, by J. C. Brown.
National Live Stock Association Meeting in Salt Lake City, by H. E. Fenn

February 20:

Range Management, illustrated, by Mark Anderson.
Range Management and Salting Plans from the Ranger's Standpoint, by C. M. Mangum.

March 13:

Agricultural and Mineral Claims on the National Forests, by C. N. Woods
Extensive Grazing Reconnaissance, by D. A. Shoemaker.

March 22:

Some Aspects of the East in War Time, by E. E. Carter.
The Fuel Situation in the United States, by C. F. Korstian.

April 17:

With the Forest Regiments in France, by Col. H. S. Graves.

NOTICE TO SUBSCRIBERS

THE War Industries Board has recently issued an order to the publishers of periodicals requesting a reduction of from 15 to 25 per cent in paper tonnage as compared with last year.

In order to comply with this order, it will be necessary to drop all subscribers to the JOURNAL who are in arrears. Since practically all subscriptions begin with the January issue, they should be renewed by January 1.

This also covers membership dues which include subscriptions to the JOURNAL.

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JOURNAL OF FORESTRY

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THE SCHOOL-TRAINED FORESTER

BY F. ROTH

Professor of Forestry, University of Michigan

Mr. Kneipp's article in the JOURNAL certainly brought out a most timely and useful discussion of a subject which is old in other lines, such as engineering, medicine, etc., but is new in forestry, in keeping with the newness of the subject in our country. After such excellent statements as those of Kirkland, Olmsted, Silcox, and others, it seems quite superfluous for me to attempt a discussion or rejoinder, and the following is intended chiefly in the nature of a vote, openly and gladly cast on this question.

Having known Mr. Kneipp for over sixteen years, it gives me pleasure, here at the outset, to testify to his excellent work, the patient persistence under very trying conditions in the old Land Office days, the ability and good judgment, as well as the highest integrity; and I am sincerely glad to be able to compliment and congratulate Mr. Kneipp on his well deserved, splendid career. I fully realize, too, that in an address such as his, where affairs of the Service are being discussed, one does not prepare a legal brief, intended to stand all tests of hair-splitting criticism, and, furthermore, I fully believe in the good intentions of helping the men and furthering the whole business of the Service as having formed the principal motive. Having this in mind and wishing merely to cast a vote and incidentally to contribute a word of explanation and suggestion intended chiefly for young men going into forestry, rather than any rejoinder to Mr. Kneipp's statements, I wish to emphasize that no offense to nor reflections on any one is intended.

The importance of the subject which Mr. Kneipp's article brought out on the barn floor to be thrashed over is certainly very great, and is particularly important at the present time in forestry. In mining and railway engineering the value of the school-bred man began to be recognized over fifty years ago; in other lines of engineering and in manufacture, much later. But today the contractor who puts down our three-mile water-pipe line is a graduate of the University of Michigan; his superintendent on our job had work at Cornell and regrets that he did not stay for a degree, and the man whom our little city hires to inspect or watch, day by day, over the work, as to its progress and quality, is a graduate engineer. But the two husky, hard-fisted men who really do the difficult and painstaking work in the laying of pipes and valves, making the proper joints, etc., are not school-bred men, but workmen with skill, experience, and much ability and judgment, and as I stand by, now and then, it seems as if a twinkle comes into the eyes of these men when they ask the young engineer, "Is it all right, boss?" At their homes and in conversation among themselves they do not always hold the young engineer very high, and many a newspaper man has gathered material for his nonsense talk on the self-made man by listening to these men. These unschooled men—or, better, these men whose schooling was in the doing—have not always been properly appreciated, but they are gradually (now rather rapidly) coming into their own. The engineer of experience respects them very highly, and the respect is mutual. This is as it should be, and let us hope it may be so in forestry. When the school-bred architects and engineers have made designs for our large building, then the contractor comes, and his superintendent and foreman set to work with their men—the few engineers in their office made work for many on the ground and in the building.

Some iron-worker, or plumber, or foreman, or even the cement mixer, may feel big and think "What would they do without me?" but the fact remains that they are all needed, each in his place, and it seems far sillier for the hod-carrier to consider himself indispensable than the engineer, even though both are needed.

That the good foreman, the skillful plumber, etc., should feel a little envy toward the school-bred engineer is quite natural; to him the engineer's pay looks big (and his own has been out of proportion, small in the past) and his life easy; in comfortable quarters, in a good suit of clothes, the goal of most men.

Now and then some industry or some establishment feels that the school-bred engineer, chemist, etc., is not needed, or may be dispensed with; the methods which built up the concern are "good enough" and are followed. But sooner or later trouble comes. Our paper-makers today are just beginning to see that the workman-foreman-superintendent never gets beyond the methods of the past. Coal gas was made in the "good old way" of wastefulness, all over the world, until the school-bred man showed them the ways whereby the by-products pay both for the coal and work and leave gas as pure profit. The story of the last fifty years in all lines of industry is full of illustrations. The modern world in all phases of its housekeeping depends for its direction, and especially depends for its progress, on the school-bred man—ground in the fundamentals and tutored in his particular field, able to understand the book and interested, through the stimulus which comes from knowledge, to read the book and to find out what others have done and are doing, and interested in trying new ways.

But the man without college training sees his superior, often less gifted but better schooled, make mistakes, sometimes fail entirely, or sees him dependent on the non-schooled man, reaping other men's glory and pay. This goes on right along and will do so for all time. Quite naturally the matter comes to the surface; now and then some striking cases get into the papers and magazines. Some excellent practitioners in surgery and medicine, in law and in engineering (notably in architecture), have been men without a college course, or with a partial course, or course in general studies but not in their specialty. In business this is even more true; fortunes have been gathered by men without any schooling, and when Joe Lester can corner the wheat, it is put on the big gong that he never had gone to college. When Joe fails and nearly ruins his father, too, there is nothing further said about the matter.

That a man may be a great lawyer, surgeon, or architect without the school training is certainly true—experience proves it; but it also proves that out of a hundred men trying surgery or law or architecture, even after all the schooling of a regular course, only a few prove to be of the "select" and make their way to the top.

The genius soars, regardless of conditions, and in our age of free libraries, illustrated works, easy travel, abundant opportunity to hear and to see and to learn from object-lessons of every kind, the genius finds soaring easy and rapid. But genius is rare; the great body is just average, and the student but little better. "About one man in ten has real head," was the answer of a man of experience, and he is probably not far wrong. If we waited for men of genius to attend the sick and injured, fill our teeth, build our railways, and work in our factories, mines, and forests, these several necessary branches would remain unmanned, and genius could go on dreaming in the vegetable garden of a very primitive world.

But for the average, for that army of men today necessary to do the brain work, the office and laboratory, the study and design work of civilized nations, we need schools; and Mr. Kneipp states this very well in saying: "Obviously they have certain decided advantages over the man without training, due to the systematic mental training which a college course usually gives, a thorough study of features of the work, and more or less familiarity, theoretically at least, with the best processes devised or formulated by the best-trained minds throughout the entire world."

This tells the whole story; the college-bred forester compares to the promoted sheepherder exactly as does the man mounted on a race-horse to the man mounted on a pony. Once in a while the pony wins, especially if it has enough start; generally it runs just fast enough to lose. Out of a hundred college-bred engineers eighty win (ten win big); out of a hundred unschooled men doing the important work in various lines of engineering *not one*, on an average, ever becomes an engineer. The rest stay at the job; they make the joints and run the machines; they are useful; we need lots of them; we pay them well; we respect them; the world owes them much. But they are not engineers and they never will be; they alone would never develop any line of engineering.

In recent years the old trade school has been revived in various forms and the correspondence school has attempted to make engineers of this class of working men. Generally, however, their students are not of this class, but are young men who feel that they cannot afford a proper course or are unwilling to spend time and effort. Some of these men do well; others, of a political make-up, take their diploma and pose as engineers, securing jobs with the smaller towns, etc., usually much to the detriment of their employers. This phase repeats itself in forestry in the graduates of short-course schools and from special schools like the "tree surgeon" outfits. A good ranger course is a most excellent preparation for the purpose for which it is intended, but its use is limited even more than is the preparation. The effort to standardize education in forestry and other lines by prescribing courses of certain duration and recognized schools is all based on an appreciation of this fact.

What has been said here of engineering is far more true of forestry. A 60-foot span steel bridge to the layman looks like a very complex affair and its erection a great feat. But compared to a living thing, such as a horse or tree, this bridge is simplicity itself, and to acquire even a moderate amount of knowledge concerning the tree, its make-up and needs, requires a great deal more study than does the understanding of the bridge. In addition, there enters another very important factor, and one which is ordinarily overlooked entirely in these discussions. It is the factor of interest. The builder of a bridge has the job, the men who employ him, his own help, the finance, etc., all actively prodding him into keeping his mind on the work. The tree says nothing to the forester, and if his own interest does not "keep him going"—that is, hold his attention, make him look and search and take note of things—he will see little in the forest, and he certainly will never do much for the forest. After eighteen years of teaching I can testify that the hardest lesson to learn in forestry, and the most difficult habit for the student to acquire, is the interest in the growing stock of the forest. And it is here, far more than in the things which Mr. Kneipp emphasizes, that the average student fails.

Turning now to experience in these matters, both abroad and here, the testimony of great facts and real accomplishment contradicts flatly most of Mr. Kneipp's assumptions. Forestry in Europe as an important industry, as good, reliable, and respected business, as a branch of applied science deserving of a literature and of special schools, was not made by the woodchopper, the hunter, the sheepherder, or the lumberman; nor was it made by the lawyer, the economist, or the botanist and naturalist, although all of these did useful service; nor was forestry made by the office-holding crowd. Forestry as it exists in Europe was built up by the educated forester, by the man who acquired all the schooling that he could get or afford, and who made forestry his business. And forestry progressed in proportion as the educated, the school-bred man became more and more general in forestry work. Even 150 years ago many of the large forests were in the hands of the hunter (*Waldgerechte Jäger* of the Germans), and mismanagement at every turn was the rule. At that time most of the small woods were cared for by the practical woodsman, the man who chopped and planted very well, but who had no insight and no outlook, and who worked along aimlessly and without plan; the miserable coppice woods of private owners and communes were the result.

And all legislation, whether "*forstordnungen*" in Germany or the famous "*Ordonnance des Eaux et Forêts*," did not spring from woodchoppers and hunters, but were the compilations of the best there was known in forestry at the time, made by school-bred, learned people, chiefly lawyers, economists, and priests.

And even in this case the necessity for the school-bred forester in the forest, and not merely the office man at headquarters, was most clearly demonstrated, for it was the lack of properly prepared men and competent supervision in the woods which brought these laws and the consequent organizations into disrepute and largely offset the good which they might have done. Forestry as a science and as a practice did not progress, except here and there where a school-educated man happened to be in charge; old recipe methods, such as the method "*à tire et aire,*" etc., established themselves, so that Lorentz, Nanguette, and others had to demolish old prejudices as late as 1850.

The first great manual of forestry was given us by Carlowitz, an educated mining engineer, a genius who used his school training to work into forestry. Real progress in forestry came with the advent of the forestry school; the important principles were worked out chiefly by men who had enjoyed a good course of higher education, by the men of universities and academies.

And today forestry in the different districts of Europe is in good or poor condition in proportion as educated foresters are or are not employed. In the Department des Basses Alpes one sees virgin stands of native spruce and fir making no income to their owners, the villages. Why? Some will say "Lack of funds." But no, the stuff is on the ground now; an American lumberman could pay good stumpage today. It is the lack of a forester, a man who knows how and can develop these properties and convert the useless and yet valuable woods into income-producing properties. Fine macadam State highways, good railroads, near-by large markets (Lyons, Marseilles, Paris), all the conditions for success are given, and yet the practical but unschooled man makes no progress; logs for buildings are dragged out by hand in deep ruts, washing into gullies, and the whole affair is medieval. Cheap stumpage exists today in the Tyrol and in many districts of Austria, while in the Black Forest practically every acre of forest is worked under a well-studied plan and pays a good income. But forestry was not developed by the school-educated forester being set at scaling and chopping or made to stick in the mountains, digging post-holes for the ranger station pasture; it was developed by putting the man at work in keeping with his preparation and making conditions for him worth his while and decent enough to induce him to stay at the work.

Very interesting in this connection is the history of the Sihlwald, where, as early as the year 1342, the city's forester was made a member of the city council, which is good evidence that the free people of Zürich appreciated the fact that it required a man of parts, and not merely a promoted woodchopper, to manage a few thousand acres of important forest and assure to the city a necessary supply of timber and fuel. Where today affairs in forestry are in a satisfactory condition, everything planned and properly looked after, it requires a well-schooled forester to about 10,000 acres of woods and, in addition, five good assistants or underforesters. These latter correspond to the men working under the engineer; they are interested, able, industrious, and reliable; they are mostly drawn from among the workmen of the forest, but of late it has been found that even for these subordinate positions a short course at a special school is very useful, and thus the secondary school (corresponding to this, our ranger school) has come to be quite universal in Europe.

That there would develop a little rivalry here, even more than between engineer and pipe-layer, is to be expected; the underforester quite commonly finds fault with the forester; his knowledge of actual conditions in the woods is far more detailed, and where this is reinforced by a superior native ability and judgment, there is real envy and friction. In recent years some of this has even crept into the forestry journals. In administration circles this has led to the proposition to reduce the number of foresters or school-bred and higher-paid men. The movement is for more money, and if it succeeds it will most certainly lead to poorer woods and less income.

In our own country a good deal of forestry history has been making, and the relation of progress in forestry and the schooled forester has been brought out most strikingly. For a century, lumbering has been an important industry in our country; since 1870 the mechanical and railway engineers have helped this industry in its development.

What has this industry contributed to forestry? Nothing whatever; on the contrary, it has devastated the forest, and thus made our beginnings, in many districts at least, most difficult and almost entirely in the nature of first-hand investment, of replanting bare lands, sadly impoverished by the ever-recurrent fires. Almost up to the present these practical men of the forest have not only done nothing to promote forestry, but they and even their technical journals have actively opposed, not only efforts at constructive work in silviculture and administration, but hindered and successfully prevented efforts at fire protection—a line of activity calculated for their own immediate good.

What we know today of improved methods in forest-fire protection has been developed almost entirely by the U. S. Forest Service, under the guidance of an organization headed and directed (through persons and books) by the school-bred forester. And it is significant that the efforts of the largest private organizations today are in the hands of Forest Service school-bred men.

Forest improvements, clear division of forests, roads, trails, phone lines, and all the good things needed in the proper conservation and management of forest did not develop under the lumberman's régime of our forests. Inaccessibility was even cultivated, and the cut-over lands of our State and region are mute witnesses to testify the simple great fact that the lumberman left the land barren and waste wherever he touched it.

As to any accumulation of necessary information, there was not a trace; the knowledge of trees and forests was foreign to the business, beyond the number of logs in a tree and the thousand feet board measure in a stand; and even this knowledge was meager and unreliable and the methods of the crudest.

The expert knowledge of the forest was generally not possessed by the men at the central office and by the owners; the forest expert of the lumber industry was the foreman of the logging camp and the cruiser, and what little these men had of forestry knowledge they kept to themselves.

All we know of forest distribution in the United States today, all we know of dendrology, of silvics and silviculture, of forest protection against fire, insects, and fungi, and even a large part of what we have in utilization, is the work of the school-bred man, with no important help whatever from the practical owner or from the workers of the woods. And it is most significant that the lumber industry today is turning to the organization guided by school-bred foresters for their statistics, for methods of cost accounting, for a clear exposition of the status of the entire industry which might gain the confidence of our people and thus work to some real relief and permanent benefit. When the lumber journal of today asks that the Forest Service, in co-operation with the industries, work out a satisfactory plan for general forest conservation, it states the simple admission and fact that the school-bred forester is needed to put our country right in matters of the forest industry. This statement is not made in a spirit of faultfinding; it was not to be expected that lumbering should develop forestry; it did nothing of this kind abroad, where it had plenty of leisure; how could it here, where the work was rushed at top speed and where help was scarce and men with proper education simply not to be had?

Matters in the range business were no better. This line of work is rather important in the National Service, and a word here seems not out of place. The owner of a large stock of cattle in the Big Horn country was in London, England; the owner of large range herds in Texas is a New York banker; the big sheepman of Wyoming is in Salt Lake City or in the United States Senate. His real expert is the herder—in many cases an illiterate Portuguese, Mexican, or even Hindoo, and in almost all cases unschooled men. Range devastation was common; a knowledge of range plants and what they required for existence and propagation was never thought of; range distribution was a matter of overbearing, crowding, and "hogging," with a diversion of adjustment by violence of the most disgusting kind. What we know of the distribution and extent of range, of forage plants, of proper range conservation and management, and all that we practice on the basis of the knowledge has come through an organization headed and directed by the school-bred forester. And if the botanist and the herder have had a share in the work it was the engineer and the rest laid pipe.

A few facts in the history of the National Forests are interesting here. The present Forest Service is thirteen years old; before that the forests were under the United States Land Office. Between 1891 and 1897 this office did not even make a suggestion sufficiently to the point to convince Congress that something ought to be done. From 1897 to 1905 the Land Office received appropriations for forest purposes, maintained an organization, and did business. But what was accomplished? Practically nothing. To say that the men were political appointees does not prove anything; there were good men—in fact, some excellent men—in that old service. Most of the men in the field were mature, had business experience, were skillful in dealing with men; several of them had good school training and some were old, experienced stockmen; some were timbermen of ability; others miners, farmers, business men. A large part of this body of men were taken over in the new Service in 1905 and proved very valuable—but not as directors, not as engineers, but valuable to carry on the work. The office force in Washington was made up of choice people, schooled and experienced. In addition, the field force had the strong and valuable backing of the congressmen of the several States. And yet things did not develop. The organization could not tear itself away from the Land Office form and was never suited to the forest work. The very policy was lacking: no one, from the Commissioner down and out, knew what was to be done with these large stretches of mountain forests and ranges. There was not one single reserve with any kind of a working plan; there was not a supervisor's office with a map that really showed anything; there was not a timber sale with a map and a report which enabled intelligent disposition of the case at Washington; the reports were so poor, generally that the secretary had long ago become suspicious and refused to approve even the things that were meritorious. The copper people were cutting all over the Uintah to suit themselves and Washington was not informed; railroads and wagon roads were built without permit or report; range disposition was mishandled generally. As late as 1902 not a single forest had a compass or outfit, even to do surveying; there was no record even of the sawmills existing on the forests; fire business was handled wretchedly on practically all forests; here and there a few rods of old prospector trails were cleared out, but generally there was no improvement—none done, none recorded—save a few unmeaning (and often untrue) statements in the ranger's report, put there because the whole organization and control was one grand nonsense performance.

What the local people thought of the outfit need not be repeated, but there certainly was no respect for this affair anywhere. At the Washington office there was more knowledge of land law in the old Division R than would be needed in all the land cases of a century, and yet it was notorious that the Forest Reserve outfit could not win a case, and when it did win one in Montana the supervisor went on a spree.

In 1905 the Reserves were turned over to the Department of Agriculture, particularly to the then Bureau of Forestry—a handful of school-bred, young foresters, with little or no real experience in forestry and, for the most part, in anything else, but a bureau under the direction of a well-schooled, able forester. The school and the book had told these men what a forest is and what must be done to make it into a business. They had traveled and seen things; they had got together and talked things; they had worked in the woods, not scaling or digging post-holes, but making forest surveys, learning to know the distribution of our forests, the types of stands, the species which compose them, and, incidentally, they heard and saw a great deal about the wood industries and about the range affairs. Most important of all was the fact that they had a common taste and interest, common schooling, and ambitions. It was a small handful and the body of the field force of the Land Office organization, as well as of the Washington office, were simply taken over. But the leaven of the forest school was there. Lack of experience on the part of the young foresters led to many mistakes, perhaps, *but the work took shape at once;* it was headed toward forestry, toward an orderly management of these vast properties. There came instructions and more instructions. The small handful had to work largely from the Washington office, and by traveling and getting not only instructions to the old crews, but also a new spirit into the old organization. It worked, and as the schools turned out more men the progress became more rapid. What the Service is today is known. It is organized forestry in the New World; it has gathered more useful information in thirteen years about our forests and our ranges, the very geography of our western country, than all the forest and range industries and all other similar agencies put together had gathered in the 100 years and more of their existence.

Practically all the things the old régime failed to do, the Service does. Today there is real administration and record; today there are maps and proper reports, and there are men to see that the work is done. Today there is real improvement in the way of trails, road, and phone lines; today there is real fire protection and even efforts at protection against insects and fungi; today the stumpage is not set at 50 cents anywhere, to the disgust of all intelligent woods people, but a man pays for timber approximately its fair value; today a mine in the Black Hills is not left to fill with water because the red tape is too long. This story might be extended into a volume, but there is no cause in this connection. Today the work commends itself and Congress appropriates millions for it. Today the Service has the respect and the support of most of the good people of the West.

The school-bred forester has been the engineer and architect and has made work for many men laying pipe and carrying brick. The average student, fresh from college, especially the poorer one or the fellow who gets promotions too fast, believes that the school is rather so-so; that his failure is due to poor schooling or his promotions due to his own special capacity, and if only that school had added "some real stuff," blasting or fitting of cross-cut saws, for instance, what a course it might give. That he would be nowhere in particular without his schooling does not occur to him until years later. It is human. And this same human feeling is coming into a part of the Forest Service today. That an unschooled crowd of today can and will never do anything with the National Forests, any more than the old crew did, all this never occurs to them; nor does it occur to these men that it was the school-bred forester who made the National Forest Service what it is. That this mistaken human feeling should take possession also of some of the school-bred men is natural; they get impatient at the young, blundering recruit and prefer the old sheepherder who has had ten or more years' of experience in a particular simple job. That the Service should fill up with unschooled people is probably true; the development of large affairs goes by waves, and the crest never stays in one place long. But Kirkland is certainly right when he warns that this carries the danger of drifting into politics, which, in case of any Forest Service much more than other lines of work, will spell disintegration by dry rot.

To some of our friends it does not seem to occur that the very establishment of the National Forests awaited the school-bred forester, whose argument, based on large European accomplishments in forestry, on forestry teaching and literature, was the first convincing argument to come before our National Government. The very job as ranger in the Land Office days—all the development and promotion, every single career in the Service—bases itself on the doings of the school-made forester.

Mr. Kneipp's article has been useful in bringing out this discussion, and with it such papers as those of Kirkland, Olmsted, and Silcox—papers which should be carefully studied by every forester and every prospective forester. But the article is also in danger of misleading and is liable to do harm, especially in three directions:

It misleads the lay world and gives basis for a mistaken policy in organization of National Forests.

It puts the only truly large and important forest organization in the New World on record as being headed backwards.

It discourages the young man planning to go into forestry from taking a regular course of training and still more from entering the National Service, for his simple instincts tell him that it is little use joining an organization where study is held in contempt.

Of the three the last is far the most serious at this time of forestry development in the United States, for what we need most today is not laws and money, but young men with thorough training; we need 50,000 school-bred foresters to guide the rebuilding of the forests of this nation.

RELATION BETWEEN HEIGHT GROWTH OF LARCH SEEDLINGS AND WEATHER CONDITIONS

By D. R. Brewster

Forest Examiner, U. S. Forest Service

It is a common experience in passing through stands of coniferous seedlings ten to thirty feet tall to notice the rapidly growing leaders of the dominant trees. A casual glance will show a surprising variation in the rate of height growth of the same tree in different years. The obvious explanation that occurs to one is that this variation is due to a corresponding variation in the weather in the different years.

On looking more closely, however, one is disappointed to observe that whereas one tree grew more rapidly this year than last, its neighbor just reversed the process and grew more rapidly last year than during the present season. This fact raises the question as to whether or not there really is any relation between rate of height growth and annual variation in weather, and, if so, what that relation is.

An opportunity for following up this question presented itself during the past year, in connection with the work of securing growth data on western-larch seedlings. Measurements of 153 trees were taken in two 20-year-old stands at the Priest River Experiment Station in northern Idaho; 41 in one stand November 18, 1916, and 112 in the other, May 11, 1917.

Both stands were on level terraces not far from Priest River, the one measured in May being on an upper bench about 50 feet above that measured in November. Soil in both cases was sandy silt, that on the lower bench being somewhat the finer, with a less porous subsoil. Soil-moisture conditions on the lower bench are better, because of seepage from above and due to a more moisture-retentive soil. Climatically both sites may be considered identical, being not more than one-eighth of a mile apart. A meteorological station has been maintained on the upper bench, about half way between the two stands, since the fall of 1911, furnishing a daily record of temperature, precipitation, wind, sunshine, soil temperature, and other physical factors.

Trees were selected at random within small restricted areas and the following measurements were taken of each:

1. Diameter breast high.
2. Age on stump, cut as nearly as possible at ground line.

TABLE 1.—*Summary of November 18, 1916, Series*

Tree description.				Mean annual height growth. 5-year period. feet.	Departure from 5-year mean annual height growth.									
Age, years.	Number of trees.	Range in d. b. h., inches.	Range in height, feet.		1912.		1913.		1914.		1915.		1916.	
					Feet.	Rank.	Feet.	.	Feet.	Rank.	Feet.	Rank.	Feet.	Rank.
14........	5	0.7–2.3	11–24	1.49	—0.15	5	+0.03	3	+0.13	1	+0.09	2	—0.11	4
15........	3	1.6–3.1	17–26	1.74	—0.21	5	—0.04	3	+0.13	2	—0.11	4	+0.23	1
16........	3	0.0–2.4	7–21	1.41	—0.18	5	+0.07	2	+0.19	1	—0.01	3	—0.08	4
17........	6	0.6–2.7	9–25	1.55	—0.30	5	+0.12	3	+0.22	1	—0.20	4	+0.15	2
18........	7	0.6–3.5	12–21	1.31	—0.01	3	+0.02	2	+0.15	1	—0.12	5	—0.02	4
19........	4	1.0–2.1	13–20	1.34	—0.31	5	+0.14	2	+0.26	1	—0.09	4	+0.01	3
20........	7	1.2–2.9	16–23	1.41	—0.22	5	+0.05	3	+0.15	1	—0.07	4	+0.10	2
21........	6	2.2–3.7	23–30	1.67	+0.11	1–2	+0.11	1–2	±0.00	3	—0.06	5	—0.04	4
Total..	41	0.0–3.7	7–30	1.49	—0.16	5	+0.06	2	+0.05	1	—0.07	4	+0.03	3

TABLE 2.—*Summary of May 11, 1917, Series*

Age, years.	Number of trees.	Range in d. b. h., inches.	Range in height, feet.	Mean annual height growth. 5-year period. feet.	1912. Feet.	1912. Rank.	1913. Feet.	1913.	1914. Feet.	1914. Rank.	1915. Feet.	1915. Rank.	1916. Feet.	1916. Rank.
10........	2	0.3–1.0	7–11	1.13	—0.08	4	+0.02	2–3	+0.17	1	+0.13	5	+0.02	2–3
11........	8	0.1–2.0	6–21	1.53	—0.38	5	+0.03	4	+0.11	3	+0.11	2	+0.12	1
12........	14	0.0–1.7	4–20	1.38	—0.19	5	+0.01	2–3	+0.17	1	+0.01	2–3	—0.01	4
13........	8	0.4–1.5	8–19	1.40	—0.05	3	—0.29	5	+0.15	2	—0.08	4	+0.21	1
14........	9	0.2–1.6	5–17	1.07	—0.09	5	±0.00	3	+0.02	2	+0.12	1	—0.05	4
15........	11	0.3–1.4	7–19	0.99	—0.03	3	+0.09	2	+0.13	1	—0.04	4	—0.16	5
16........	14	0.4–4.4	9–30	1.50	—0.06	4	+0.05	2	+0.11	1	—0.11	5	+0.02	3
17........	18	0.8–4.0	12–30	1.56	—0.03	4	+0.02	3	+0.11	1	—0.18	5	+0.08	2
18........	13	1.4–4.7	17–32	1.70	+0.02	3	—0.06	4	+0.08	2	—0.14	5	+0.09	1
19........	5	1.3–2.3	15–22	1.57	+0.17	1	—0.01	4	+0.07	2	—0.31	5	+0.06	3
20........	7	1.0–3.3	17–30	1.58	+0.12	2	+0.09	3	+0.13	1	—0.15	4	—0.17	5
22........	2	1.8–3.0	19–27	1.81	+0.24	2	+0.14	3	+0.29	1	—0.31	5	—0.28	4
Total..	112	0.0–4.7	4–32	1.46	—0.05	5	—0.01	2	+0.11	1	—0.03	4	—0.02	3

3. Total height.

4. Distance between annual nodes of height growth on the main axis for the past five seasons.

Some difficulty was experienced in getting the complete growth for the last season on some of the trees, since the extreme tips of larch seedlings of this size are very weak and brittle. When the trees were struck at the base with an ax, the sudden whipping of the tip through the air caused the last few inches to be snapped off from about one-third of the trees measured in May—40 out of 112. Such trees with broken tips were discarded in the November work.

The tips were usually scattered beyond recovery, but enough were recovered to permit of a close estimate of the average length of such broken tips. There was little variation in the cases observed and it was estimated that the length would average at least three inches. It would, if anything, be a fraction over this; so that the figure is conservative. Accordingly an addition of three inches was made to the 1916 height growth of each of the trees with broken tips measured in the spring series.

The figures were first assembled by grouping the trees in one-inch diameter classes. This was not found to be satisfactory, because of the wide variation in ages of trees in each group. The effect of the natural acceleration in height growth, which may be expected with increasing age at this period in the life of the tree, was open to question and made it difficult to draw fair conclusions as to the effect of climatic changes in the different years.

Because of this question as to the effect of age, the trees were then grouped by years of age as counted on the stump. While it is difficult in such work to determine the age in all cases to the exact year, it is thought that the age of a majority of the trees was determined correctly. Tables 1 and 2 summarize the data by age-groups.

TABLE 3.—*Summary of Tables 1 and 2, Showing Rank in Height Growth by Seasons*

Rank in height growth.	Summary of rank in height growth, by years.				
	1912.	1913.	1914.	1915.	1916.
First	2	1	13	0	4
Second	2	7	5	3	4
Third	4	8	2	1	3
Fourth	3	3	0	7	7
Fifth	0	1	0	8	2

NOTE.—In case of a tie each season is given the higher rank.

The most striking fact brought out by the tables is the consistent lead in height growth shown for the season of 1914. This is true of the different ages in each series, independently, as well as in the averages. 1914 takes first rank in at least one case for all of the thirteen ages included, with the exception of 11 and 13 years, which are in third and second rank respectively. In no case does 1914 fall below third rank and is third only twice out of twenty times.

The relationships of the other seasons are also fairly constant, although they show more variation than does 1914. The averages for the two series show an identical ranking for each of the five seasons. The individual ages check with the rank shown by the averages in a sufficient number of cases to show a fair consistency throughout.

Seasonal change in weather is clearly the dominant factor influencing rate in height growth between the ages included in the study. A tabulation of the data in Tables 1 and 2 so as to group height growth according to the year of the tree's age, rather than season, showed no well-defined relation between year of age and relative height growth. This holds true of the individual trees as well as the averages for each age. It may reasonably be concluded, therefore, that the influence of age at this period in the life of the tree is subordinate to changes in the weather and physical factors which affect tree growth directly or indirectly.

The fact that height growth was so consistently greater in 1914 than in the two years just preceding or following raises the question as to whether the season of 1914 differed from the others in any marked way. A detailed analysis of all the climatic records obtained during this period is scarcely within the scope of this study. Furthermore, the growth data are hardly intensive enough to warrant such a procedure. It is felt, however, that the relationships between growth and climatic changes can be indicated, at least in a general way, by limiting the comparison to three factors: air temperature, precipitation, and cloudiness.

Air temperature can, it is thought, be expressed in sufficient detail for this study by using the mean monthly temperature—the mean of the daily means of the maximum and minimum readings. Precipitation needs a somewhat more detailed treatment, since its distribution and the length of dry periods have an important influence upon growth. The amount of sunshine can be indicated in a general way by the number of days in each month classified as "clear" (0.0 to 0.3 cloudy), "partly cloudy" (0.4 to 0.7 cloudy), and "cloudy" (0.8 to 1.0 cloudy).

General observations of larch indicate that height growth starts in the latter part of April or first of May and is practically complete for the season by the middle or end of July. Climatic records for the months of April, May, June, and July are, therefore, all that need be included in a study of the direct relation between climatic variations and rate of height growth. A summary of the climatic data for these months in the years 1912, 1913, 1914, 1915, and 1916, for meteorological station number 3 at the Priest River Experiment Station, is given in Tables 4, 5, and 6.

The observations which form the basis of the climatic records were made by Forest Service officials in co-operation with the U. S. Weather Bureau. Standard meteorological instruments were used.

In temperature, the year 1914 shows somewhat higher figures than the other years, ranking first in the months of May and July and ranking slightly the highest for the four-months' period as a whole. A lead of 2.1 degrees above the average for the month of May, in the year 1914, would indicate more than ordinarily good growing conditions, particularly if accompanied by plenty of moisture. There is, however, a considerable and rather inconsistent variation in temperature for the five years as a whole, and it seems doubtful if much weight can be given the indications of mean monthly temperature taken separately.

A definite lead is shown by the year 1914 in the number of "clear" days, both in the average and for the months of May, June, and July—the growing months. This, when coupled with the higher than average temperature conditions in that year, would be favorable to an unusual amount of growth, other factors being equal.

Precipitation figures, in the form of monthly totals, are contradictory and show no distinct tendencies. The response which the growing plant makes to differences in amount of precipitation is apt to be very indirect unless the amounts approach the minimum needed by the plant. Excessive amounts beyond what the plant requires and can utilize under the given temperature and light conditions will produce little, if any, effect in the form of growth. It is evident from the figures in Table 6 that in some months an exceptionally heavy precipitation occurred, which was probably more than the trees could utilize fully. Moreover, this was often largely concentrated during short periods, making a considerable portion of the total unavailable for the use of the tree because of heavy loss in run-off.

In order to determine whether an analysis of the daily precipitation would bring out any relationships between rainfall and growth the daily amounts were platted, as shown in figure 1.

TABLE 4.—*Air Temperature*

Factor.	Year.	April. Amount.	April. Rank.	May. Amount.	May. Rank	June. Amount.	June. Rank.	July. Amount.	July. Rank.	Four months. Amount.	Four months. Rank.
Air temperature Five-year average of mean monthly temperatures	5 years	44.1	..	50.1	..	57.0	..	61.3	..	53.1	..
Departure from five-year monthly mean, by years..	1912	—0.7	3	+1.4	2	+3.6	1	—0.7	4	+0.9	2–3
	1913	—2.3	5	—0.7	4	+1.1	2	—1.5	5	—0.8	4
	1914	+0.5	2	+2.1	1	—1.4	3	+2.6	1	+1.0	1
	1915	+4.1	1	+1.1	3	—1.6	4	—0.1	2	+0.9	2–3
	1916	—1.7	4	—4.1	5	—1.6	5	—0.3	3	—1.9	5

TABLE 5.—*Cloudiness*

Factor.	Year.	April. Amount.	April. Rank.	May. Amount.	May. Rank	June. Amount.	June. Rank.	July. Amount.	July. Rank.	Four months. Amount.	Four months. Rank.
Number of "clear" days, by years	1912	0	5	7	3	12	3	8	4–5	7	5
	1913	12	2–3	19	1–2	13	1–2	23	2	17	2
	1914	12	2–3	19	1–2	13	1–2	27	1	18	1
	1915	14	1	2	5	10	4	9	3	9	3
	1916	11	4	5	4	8	5	8	4–5	8	4
Number of "partly cloudy" days, by years...........	1912	24	1	11	2–3	7	4	11	2	13	1–2
	1913	9	2	4	5	5	5	5	4	6	5
	1914	8	3–4	7	4	10	3	2	5	7	4
	1915	8	3–4	16	1	12	2	15	1	13	1–2
	1916	7	5	11	2–3	16	1	10	3	11	3
Number of "cloudy" days, by years	1912	6	5	13	2–3	11	2	12	1	11	1
	1913	9	3	8	4	12	1	3	3–4	8	4
	1914	10	2	5	5	7	4	2	5	6	5
	1915	8	4	13	2–3	8	3	7	2	9	2–3
	1916	12	1	15	1	6	5	3	3–4	9	2–3

TABLE 6.—*Precipitation*

Factor.	Year.	April. Amount.	April. Rank.	May. Amount.	May. Rank.	June. Amount.	June. Rank.	July. Amount.	July. Rank.	Four months. Amount.	Four months. Rank.
Precipitation											
Mean monthly precipitation for five-year period........	5 years	2.14	..	2.70	..	2.03	..	2.07	..	2.39	..
Departure from five-year monthly mean, by years..	1912	+0.32	2	−0.02	2	−0.40	4	+0.51	2	+0.08	2
	1913	−0.81	5	−0.46	5	+0.68	1	−0.85	5	−0.36	5
	1914	+0.44	1	−0.34	4	+0.31	3	−0.24	3	+0.04	3
	1915	+0.20	3	+0.95	1	−1.10	5	+0.98	1	+0.25	1
	1916	−0.14	4	−0.11	3	+0.60	2	−0.41	4	−0.02	4
Number of days with 0.01 inch or more of rain, by years	1912	13	3	12	5	8	5	16	1	12	3–5
	1913	12	4	13	3–4	14	3–4	8	3–4	12	3–5
	1914	16	1	13	3–4	15	1–2	4	5	12	3–5
	1915	9	5	21	1	14	3–4	15	2	15	1
	1916	15	2	16	2	15	1–2	8	3–4	14	2
Number of days with 0.10 inch or more of rain, by years	1912	6	3	8	3–4	7	3	7	1–2	7	2–5
	1913	5	4–5	8	3–4	9	2	4	3–5	7	2–5
	1914	5	4–5	9	2	10	1	4	3–5	7	2–5
	1915	7	2	10	1	6	4–5	7	1–2	8	1
	1916	9	1	7	5	6	4–5	4	3–5	7	2–5

A study of the chart brings out the fact that the rainfall in 1914, while only average in amount, compared to the other years, was very evenly distributed during the period of most rapid height growth. Good soaking rains occurred regularly at intervals of from four to ten days from the middle of April to the middle of July, with smaller showers between in most cases. The two rainy periods in June were probably exceptionally favorable to growth. In each case a heavy rain was preceded by lighter showers, giving the ground a chance to become soaked to a good depth. The rainy period was then followed by a week or so of warm, growing weather, with an abundance of soil moisture available to the roots.

In contrast to the year 1914, the other seasons show much more prolonged periods during which no heavy soaking rains occurred. Much more irregularity in the quantities of rain during the different rainy periods is also shown. Some were merely a series of light showers which would not be able to penetrate the soil to any great depth. Others, again, were heavy isolated rains which were concentrated over short periods and preceded or followed by several days of dry weather, leading to maximum loss from run-off and evaporation. The effect upon growth of regularity or irregularity of distribution of rainfall within the limits here shown is, of course, purely a matter of speculation, but it is not unreasonable to think that moisture conditions in 1914 were at least fully as favorable, if not more so, than in any of the other years.

In conclusion, it must be admitted that the data here presented are inadequate to definitely establish any clear relationship between height growth and climatic factors. Yet there is a consistent, if somewhat circumstantial, series of indications which all lead to the tentative conclusion that the year 1914, with its relatively high temperatures, its maximum of sunny days, and its sufficient and evenly distributed rainfall, produced favorable growing conditions which were directly reflected in the greater height growth shown for that year. Temperatures in other years were just as high or higher; there were just as many clear days, and rainfall was just as great and as evenly distributed. Yet in no case were all these favorable factors combined in the same years and months to the extent shown in 1914.

Taking the evidence of average amount of growth in the different years as a basis, it seems justifiable, therefore, to conclude that rate of height growth of larch seedlings does vary in accordance with variations in weather conditions from year to year, and that the most favorable conditions for rapid height growth are produced in the North

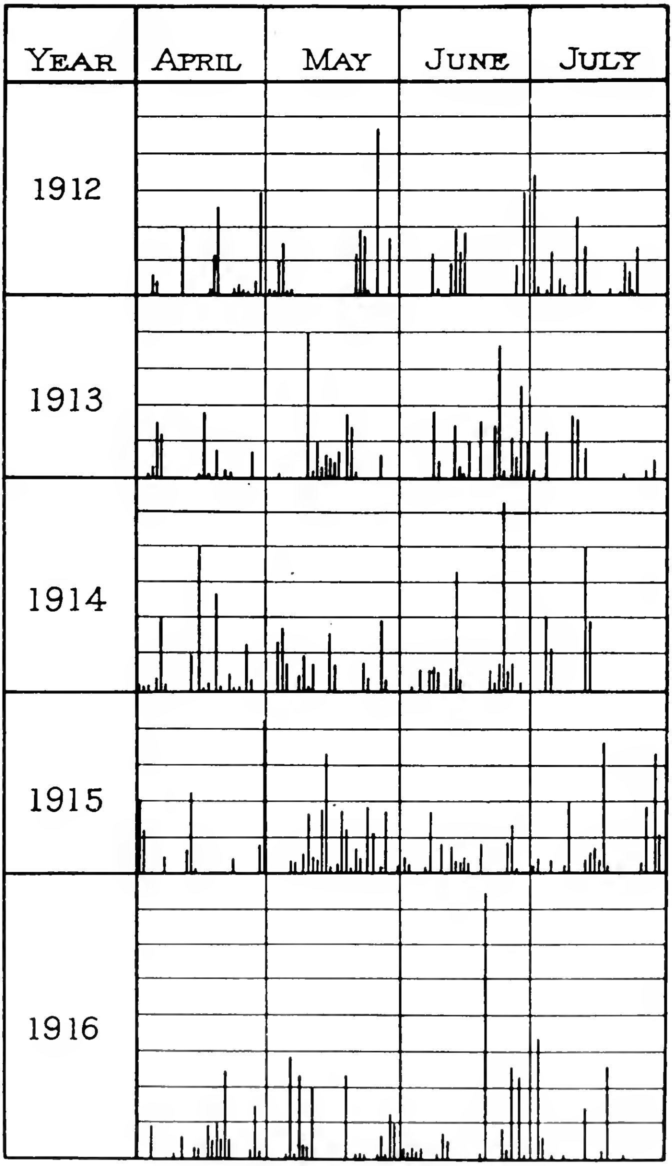

FIG. 1. *Daily precipitati*

Idaho region by a combination of temperatures somewhat above the average, coupled with a high percentage of clear days, with an average amount of precipitation evenly distributed in the form of good rains at intervals of four to ten days preceded and followed by lighter showers. This conclusion, while in harmony with the laws of plant physiology, must, however, be considered tentative until supported by more intensive study, and is presented at this time with the hope of stimulating discussion and further study along the lines indicated.

SOME FUNDAMENTAL CONSIDERATIONS IN THE PROSECUTION OF SILVICULTURAL RESEARCH

By Richard H. Boerker

IV. The Present Status of Government Research Work

I have already spoken of three fundamental considerations in the prosecution of silvicultural research in the three previous papers of this series, Parts I, II, and III, in the November issue, and I briefly discussed them quite apart from the numerous suggestions that have been made by various foresters upon these same subjects. In order to better support my contentions and to fortify the position I have taken in regard to them, I am giving in this paper numerous citations from recent forestry literature to show that the suggestions I have made and the few that I still intend to make find direct application in Government research work at the present time.

Within the last two years the subject of forestry research, especially silvicultural research, has been given the discussion which it rightfully deserves, and that by several very able foresters, so it was with considerable reluctance that I attempted this series of papers upon the subject. Dr. B. E. Fernow[1] about two years ago, before the Society, made some suggestions as to the possibilities of silviculture in America, which sums up the situation so well that I quote *in extenso:*

"We will have to confess, we teachers of silviculture, that the knowledge we propound is of a most general character, which fails to suffice when it comes to applying it in a given specific case. Silviculture is still an empirical art, relying upon trial and experiment to find out the *modus operandi.* We must realize that all we can learn of silviculture as practised abroad is principles, and then not always firmly based.

"With a hundred years of experience behind them, with only a very limited number of species to propagate, with only limited territory, and that means limited climatic conditions, the practitioners of Europe are still at variance on almost any silvicultural practice. Opinions and judgments, not specific prescriptions, rule to a large extent. If this is so even in the fatherland of forestry, what shall we expect as regards application under vastly different and vastly varying climatic conditions, with an entirely different set of species, and a large number of them to deal with, and without experience?

"Ignorance becomes excusable under such conditions and it is justifiable to hesitate before applying untried methods on a large scale.

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[1] B. E. Fernow: Suggestions as to Possibilities of Silviculture in America. Proc. Soc. American Foresters, XI: 2, pp. 171-176, 1916.

"It is my belief that at present all energies ought to be bent on making silvicultural studies, on securing by field work and experiment the biological and ecological knowledge which should underlie silvicultural practice.

"I suppose the Forest Service Experiment Stations are doing this.

"I would, however, accentuate that only the best men—best as to knowledge, imagination, and judgment—can be expected to secure trustworthy results. Indeed, specialists who are thoroughly competent to apply modern methods of ecological research are needed for this work.

"Beware of doctrinaires is my parting advice! They have kept silviculture back for a century, even in Germany."

About a half year later Barrington Moore[2] ably pointed out at least three essential guiding principles which must eventually be followed in this kind of work. He pointed out the necessity of recognizing the research type of mind as something quite apart from the directive or administrative type; he emphasized the necessity of the purely scientific point of view rather than the practical and often materialistic; and he expressed the idea that it is folly to expect an administrative officer to do justice to this highly specialized type of work or to have him direct research men. Only a few months later Dr. Fernow expressed the second of these in an address before the Society of American Foresters.[3] In reviewing the progress made by forestry in this country in the last thirty years he said this about forest investigations:

"So far, however, the accent in the investigations is still laid on the forest products side—which at one time was not even held germane to forestry—and the silvicultural side is as yet not fully considered. Out of 162 listed problems nearly one-half are occupied with forest products and less than 30 with real forestry problems.

"To my mind the most important knowledge we are lacking is how to solve the silvicultural problems for our species, for our soils and climatic conditions, for the reproduction of the timber we are cutting and for the recuperation of our cut over and wasted forest lands in the East as well as in the West. When we have learned this lesson, we may be justified in speaking of what the early pioneers talked of too prematurely as 'American Forestry.'"

Clapp, in a paper delivered at the same meeting,[4] hit the nail on the head when he said:

"Scientific research is . . . at the foundation of permanent forest development in the United States."

He urged three steps to advance the research work in this country: (1) The publication by each research agency and organization of a

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[2] Barrington Moore: The Relation of Forestry to Science. Forestry Quarterly, XIV: 3, pp. 375-9, 1916.

[3] B. E. Fernow: The Situation. Journal of Forestry, XV: 1, pp. 3-14, 1917.

[4] Earle H. Clapp: The Correlation of American Research. Journal of Forestry, XV: 2, pp. 165-75, 1917.

statement indicating the projects investigated and the scope of the work; (2) the correlation of forest research work carried on by the numerous and scattered agencies all over the United States and co-operation among these agencies; and (3) the stimulation of research among those agencies not sufficiently active. This is, we will agree, sound advice.

Frothingham[5] presented a paper about the same time, at the New York meeting of the Ecological Society of America, in which he pointed out how ecological knowledge must be applied in handling the forests in the Southern Appalachian Mountains. He said:

> "Before the management of this great forest can be attempted intelligently we must know more about the species and their habitats. This basic information centers around the selection of species for management as one of the first aims of silviculture."

He then went at length in enumerating what silvical knowledge must be secured. He explained the two methods which must be followed to secure this knowledge: one, a long-time intensive investigation; the other, short-time extensive observation. For immediate practical results the Forest Service has used the latter. This has given valuable data which is to serve as a groundwork for general silvicultural policy. Concerning the intensive method, Mr. Frothingham said:

> "The time will come, however, and possibly even before trees now started have reached their maturity, when we shall need to practice more intensive forestry. We shall be sadly negligent if before this time silviculture has not at hand all the data needed for intensive practice, and to this end the intensive method of study must be used. There is no good reason why work along experimental lines should not be undertaken at once. . . . The field for experimentation is very large, and, once started, the special direction in which the work can be of greatest service will become clear."

Bates,[6] in a paper presented at the New York meeting of the Society in 1916, *en passant* referred to the friendly criticism of certain foresters ([1] and [2]) concerning the forest investigations of the Forest Service. These criticisms, he said, have conveyed the idea that the investigations are not producing their share of fundamental scientific knowledge. However, he added:

> "I must confess to feelings, at times, entirely in keeping with the ideas expressed by them. It has struck me that our experimentation has been of too

[5] E. H. Frothingham: Ecology and Silviculture in the Southern Appalachians: Old Cuttings as a Guide to Future Practice. Journal of Forestry, XV: 3, pp. 343-49, 1917.

[6] C. G. Bates: The Biology of Lodgepole Pine as Revealed by the Behavior of Its Seed. Journal of Forestry, XV: 4, pp. 410-16, 1917.

limited a scope, representing, as it so often does, a purely local test of the 'best method' of performing some silvicultural operation. This is true of nearly all of our work in reforestation, natural regeneration, and thinnings."

The author at various times ([7], [8], [9]) has pointed out the need of silvical and silvicultural research, the value of purely scientific investigations, the necessity of freeing research men from administrative organizations, and many other matters already mentioned above.

I suppose I could go on almost indefinitely quoting passages from recent forestry literature upon the necessity of conducting silvical and silvicultural investigations, but time and space will not permit it. Before leaving the large number of citations which I have collected upon this subject and which I have before me as I write, I wish to quote one more passage, which is probably more specific and more to the point than any I have seen. The passage in question is from a recent article by Dr. C. D. Howe, a Canadian Forest ecologist, entitled "Forest Regeneration on Certain Cut-over Pulpwood Lands in Quebec," reprinted from the Ninth Annual Report of the Commission of Conservation, Ottawa, 1918. What he has to say is just as applicable to American conditions:

"We talk easily of what we should do with a forest. In this particular case we want to increase the proportion of spruce, the most valuable species at present on this cut-over land, or at least we would like to restore it to its former position in the forest. How can this be done? One man says: 'Cut heavier, open up the crown cover, let in the light.' Another man says: 'Make a lighter cut, disturb natural conditions as little as possible.' The result cannot be obtained by methods so directly opposed. What is the answer? The answer is that neither man really knows what he is talking about. Your opinion may be just as good as mine, because both have been spun out beneath our hats, or evolved from smoke rings, as we sat in our office chairs. We have no accurate knowledge, no definite records, no actual measurements by instruments of precision, of the conditions as they really exist in Canadian forests. I repeat what I said in the beginning. We have been discussing the management of our timber resources for 30 years, but, as yet, we have not the fundamental knowledge of conditions on which it is necessary to base our plans, if we were asked today to put them into operation. What definite knowledge we do have as to conditions in which trees grow is borrowed from other countries, even European countries, whose conditions are not our conditions. Is it any wonder that we are groping in the dark? And we will continue to grope in the dark

[7] R. H. Boerker: Some Notes on Forest Ecology and Its Problems. Proc. Soc. Am. Foresters, X: 4, pp. 405-22, 1915.

[8] ———: Ecological Investigations upon the Germination and Early Growth of Forest Trees. Nebraska Studies, XIV: 1, pp. 1-89. Lincoln, Nebraska, 1916.

[9] ———: A Historical Study of Forest Ecology; its development in the fields of Botany and Forestry. Forestry Quarterly, XIV: 3, pp. 380-432, 1916.

with this matter until we obtain actual experimental records of those environmental conditions that fashion a forest."

Such, then, are some of the criticisms and suggestions that have been made relative to silvical and silvicultural research in this country, in most cases by foresters whose wide experience has rendered them competent to understand the situation and has made their opinions valuable. In order to appreciate these suggestions *in toto*, I am summarizing them under the following 12 headings. If we agree that a majority, at least, of the criticisms are well taken, the next question that naturally suggests itself is: *What are we going to do about it?* Do not these opinions suggest the necessity of inaugurating a more definite research policy, which will be followed up by a more definite plan of action?

1. The silviculture now taught is too general and does not suffice in a given specific case. Experience, supported by trials, experiments, and observations, is necessary to furnish specific information.

2. Only the best men—best as to knowledge, imagination, and judgment—can be expected to produce trustworthy results.

3. We need specialists competent to apply modern methods of ecological research to our silvicultural problems.

4. We should recognize the research type of man as distinct from the administrative type.

5. We should not put administrative men in charge of research or research men.

6. We should realize that the purely scientific point of view is more fundamental than the practical.

7. Too small a portion of Government money and men is devoted to real forestry problems.

8. Too much emphasis in Government research is placed upon the forest products side.

9. Silvical and silvicultural knowledge is our greatest need if we are ever to have a science of American Forestry.

10. American research should be correlated, the agencies should co-operate, and research should be stimulated among those agencies not sufficiently active.

11. More intensive forestry, which is sure to come in the near future, demands intensive silvical and silvicultural research, and it is very necessary to have the data on hand when it does come.

12. Forestry research is not producing enough fundamental scientific data. Experimentation is now of too limited scope and application.

Doubtless some of these overlap, but in the main I think they are different propositions. I do not intend to comment upon all of these suggestions, because the size of the paper would not permit it. Furthermore, criticisms 1, 2, 3, 4, 5, 6, and 9 have been more or less touched upon by me in the three previous papers of this series. In this paper I wish to bring more facts and figures to bear upon two of the criticisms made above, namely, that the Government investigative program is too one-sided, and that in Government work research should be as much as possible divorced from administrative work. But before discussing these two questions, it is necessary to briefly refer to the historical development of Government investigations, to the emphasis that has been placed upon the forest-products side of research, and, finally, to the insufficient consideration that has been given to the more fundamental silvical and silvicultural problems.

During the infancy period of the federal forestry movement, the needs of forest organization, forest administration, and forest protection have been so urgent that forestry investigations were, necessarily, relegated to the background. Now, however, that the main problems of this nature have been solved, it behooves us, I think, to turn our attention to a more fundamental phase of forestry—forestry research. This has, in a measure, already been done. What has been accomplished is laudable; but, as Dr. Fernow has pointed out, the fundamental problems have as yet been left practically untouched.

At numerous times ([7], [8], [9]) I have called attention to the necessity of attacking our real forestry problems. Judging from the citations which I have made from recent forestry literature, other foresters, much more capable of diagnosing the situation than I, have made similar suggestions. To summarize the situation, we might say that satisfactory progress has been achieved in the utilization investigations of National Forest wood products, the work of the Forest Products Laboratory, and in industrial investigations. In the realm of silvical and silvicultural investigations some progress has been made, undoubtedly. Taken by themselves they do not make a poor showing; but compared to the time and effort that have been devoted to forest-products investigations, the results along that line are not encouraging. We are still far behind, considering the needs and demands which silvicultural management, forest protection, and other lines of work are making daily upon the practicing forester. He is making mistakes—yes, groping in the dark—because science has not kept pace with the needs of practice.

Fundamentally, silviculture, or timber growing, is the improvement and direction of natural forces for the production of economic values in the forest. Silvical and silvicultural investigations, therefore, seek to discover natural laws, verify them, and then apply them to the production of forests. Forest-products investigations deal with the end product—wood. To be logical, we should first learn to grow forests before we attempt to study the products and the by-products of the forest. If the present policy were carried far enough, we might find ourselves in the anomalous condition of being without wood products for the lack of knowledge how to grow them. This is, to be sure, *a reductio ad absurdum,* but it is a logical deduction. Furthermore, it emphasizes the fact that silvicultural problems are more fundamental.

I wish to go a little further into detail than my predecessors to show the inadequacy of the investigations in silvics and silviculture as organized at the present time in the Forest Service. I realize that there is no doubt a good reason for every *modus operandi* which the Forest Service has employed in its research work. To some extent economic, financial, and political considerations, unfortunately, enter into this work, due to the manner in which research work is organized. But even aside from these inherent characteristics, no one will say that there is not room for improvement. If this were not the case, there would be no excuse for any further discussion of the subject. The men whom I have quoted at the beginning of this paper ought to be proof enough for this statement. I wish, then, to point out a few needs in this direction, as I see them, and as many research men have seen them in the past.

THE ONE-SIDEDNESS OF THE FOREST SERVICE INVESTIGATIVE PROGRAM

Fernow[12] pointed out that less than 20 per cent of the problems investigated by the Forest Service were real forestry problems. In looking over the investigative program of the Forest Service for the fiscal year 1917,[13] it likewise is striking to note the small percentage of money that is appropriated for real forestry problems. By way of comparison, the following table is offered:

Forest products investigations:	
National Forest utilization studies	$21,560
Industrial and statistical investigations	22,820
Forest Products Laboratory supervision	8,080
Timber physics	22,600
Timber tests	24,000
Wood preservation	20,960
Wood distillation	27,140
Pulp and paper investigations	26,420
Lumber industry studies	4,460
Total	$178,100
Range investigations	30,660
Silvicultural investigations:	
Dendrological studies	8,450
Forestation studies	28,010

[12] Loc. cit., page 2.

[13] Program of work of the United States Department of Agriculture for the fiscal year 1917. Washington, D. C., 1916, pp. 230-246.

Management studies	24,028
Volume, growth, and yield studies	7,650
Tree studies	14,050
Study of forest influences	3,000
Protection studies	2,900
Woodlot studies, farm woodlot survey, library, computation, private forestry, and State co-operation	30,530
Total	$118,618

In looking over this list the only real forestry problems are the dendrological studies, the forestation experiments, the management studies, the growth and yield studies, the tree studies, and the experiments on forest influences. The total expenditure for all of these combined was $85,188, or a little over 25 per cent of the total expenditure of $327,678, while investigations in forest products received about 55 per cent of the total appropriation.

The beginning point in real forestry investigations is undoubtedly to learn the requirements of the species of trees with which we are dealing—in other words, find out how to use the tools with which we must do our forest building. Dendrological studies are therefore fundamental. We need to compile the existing information and secure new data upon the distribution, character, occurrence, and habits of our important forest trees. Forestation experiments give us data for reforesting our waste lands, and tree studies furnish data on the life histories and requirements of our trees. Yet all these studies received a financial support amounting to only $50,510, or about 15 per cent of the total appropriation for all investigations. While dendrological studies received $8,000, the single item of timber tests carried on in the Forest Products Laboratory received three times this much. The appropriation of $28,000 for forestation experiments would seem liberal, but on the forest-products side we find the items of timber physics and timber tests receiving a total appropriation of almost $47,000.

Of all silvicultural problems, management studies, to my mind, are the most important. These deal primarily with the best methods of cutting timber to secure reproduction and still leave the stand in the best silvicultural condition. As we cut our virgin stands for the first time, we are in an excellent position to learn the fallacies of our present systems of silvicultural management and thus to be able to gauge our future operations accordingly. These data are secured by means of studies on sample plots over a long period of years. Yet such investigations as these receive less financial support than such products studies as those dealing with wood distillation and the manufacture of pulp and paper. Next to management studies in importance I should rank studies dealing with the volume, growth, and yield of our important forest trees. These are of the utmost importance for handling timber sales and for all phases of management, valuation, and the regulation of cut. Yet these studies receive a financial support amounting to less than what it costs to supervise the Forest Products Laboratory. Other comparisons could be made, but in each case to the detriment of the real forestry problems.

I wish to digress a moment to the appropriations for another bureau of the Department of Agriculture, namely, the Bureau of Plant Industry. I cite this bureau as one in which the value of purely scientific work is thoroughly appreciated. Few governmental bureaus in the world do more for the welfare of the people whom they serve than this bureau. About 85 per cent of the appropriation for the bureau is for research work, and this item in 1917 carried an appropriation of about $1,800,000.[14] Keeping in mind the real forestry problems Fernow spoke of[15] and which carried a total appropriation of about $85,000, consider the following in this bureau:

Dry land agriculture investigations	$167,120
Cereal investigations	140,585
Pomological investigations	128,147
Foreign seed and plant introduction investigations	107,080
Forest pathology investigations	92,421
Forage crop investigations	92,980
Western irrigation-agriculture investigations	88,980
Horticultural investigations	80,333
Corn and sugar-beet investigations	84,775
Soil bacteriology investigations	39,050

These are only a few of the items. There are scores of others. These figures suffice to show that real forestry investigations—all forestry investigations, for that matter—have not received the governmental support to which their importance in our national welfare entitles them.

There are no doubt reasons why the forest-products side of forestry investigations have been emphasized in the past at the expense of real forestry research. The practical side of these investigations is plain to the people. From a purely political standpoint, they are a sure means by which the Forest Service can win favor with the people and their representatives, and thereby not only strengthen the position of the service in Congress, but also indirectly increase the annual appropriations. When we consider the wiles and whims of democratic government, these matters are worthy of consideration. But even granting

[14] Loc. cit., p. 12.
[15] Loc. cit., p. 2.

this much, there is no excuse for losing sight of the real forestry problems, which are the *sine qua non* of all scientific forestry, and the problems which, if we are some day to have a science of American forestry, must be solved.

In making a plea for more investigations in silvics and silviculture—real forestry problems—I wish to remind the reader that the general public, who is paying for these investigations, has come to understand that because a piece of research work is theoretical it is not necessarily unpractical. "Theoretical" and "unpractical" are no longer viewed with suspicion, as being synonymous. Proof of this statement can be found in the fact that a large part of the investigations of our agricultural experiment stations, while largely purely scientific and theoretical, has won the approbation of the people, because they have found out that the theoretical is the most practical in the long run. Thus it will be with our purely scientific forestry research.

DIVORCING RESEARCH WORK FROM ADMINISTRATIVE

What I have said about the research and the administrative type of man points to the conclusion that these are two distinctly different jobs. Other factors permitting, the two classes of work should be done by different types of men.

I have already pointed out ([9]) that other forestry-practicing nations have recognized this difference and have associated their forest experiment stations with forestry schools and not with the bureaucratic forest service of the state or nation. I have also attempted in this connection to point out some of the advantages of this association and intend in the present paper to go into that part of the subject more fully.

In Prussia, which has one of the largest investigative organizations, the central forest experiment station (as distinguished from the many substations in the woods) is connected with the Forest Academy at Eberswalde, whose director is at the same time the head of the experiment station. It comprises six departments, each in charge of a chief: forestry proper, meteorology, geonomy, plant physiology, plant pathology, and zoölogy. Other states of Germany have substantially the same organization, as well as France, Hungary, Sweden, Switzerland, India, and others. Only very recently (May, 1917) Sweden opened a new forestry school and forest experiment station. These are located together on the same tract of land, just outside of the city of Stockholm. In short, the forestry-practicing nations of the world have recognized that such an organization is essential to good research work.

The mere fact that this system has been adopted almost universally is an indorsement of its merit.

In this country, as we well know, the forest experiment stations are a part of the Federal Forest Service organization, and as such are subject to the whims and wiles of administrative officials and to various setbacks due to inadequate appropriations. No better proof of this could be found than in the fact that recently two forest experiment stations were abandoned and the work at most of the others considerably reduced, due to "the concentration of investigative work and the limited amount of funds available."

It is not very probable that the forest experiment stations under present methods of organization could by any manner or means be taken from the control of the Forest Service and placed in charge of the forestry schools. This, I think, is an unalterable premise and will not permit of any further discussion. The problem must be approached from a different angle. Rather, it must be stated thus: Under present conditions of organization, how can research work be left relatively free and unhampered? In this connection Clapp,[19] the assistant forester in charge of research work, is authority for the following statement:

"The entire experience of the Forest Service in research clearly emphasizes the need of a special force of well-trained men who shall be permitted to devote their entire time and efforts to the work."

There is no doubt as to the desirability of such a force of men; the question is how to get them and have them work free and unhampered.

The directors of the experiment stations have had to devote a large part of their time not only to supervising administrative work, but actually doing such work themselves. The investigative man at the stations should not be hampered with this work. There is absolutely no reason (it is a matter of more adequate funds) why this sort of work cannot be handled effectively by a capable forest ranger. There is absolutely no need of burdening a scientific man with such matters as the construction of roads, trails, fences, and houses, the splitting of firewood and similar activities. This involves not only the diverting of his attention from his highly specialized line of work, but it is unfair to expect the research man to do justice to the kind of work for which by nature he is not fitted.

If the administrative work were handed over to a ranger, another stumbling block would be removed. The Forest Service would then probably find itself free to employ research men regardless of their

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[19] Loc. cit., p. 3.

ability as administrative men. So completely has the research bureau of the Forest Service become obsessed with the idea that research men must be at the same time administrative men that research men of good standing, capable, according to the associate forester, of rendering excellent service in research, have been railroaded out of the Service because they have lacked administrative ability. In short, there is at the present time no position open to purely research foresters in the Forest Service. Is such a policy in the best interests of forestry research? Is it conceivable that there is no employment in the Forest Service today for a forester who wants to devote his life to research work? Strange and unfortunate though it may seem, there is not.

If research work in the Government service is to attain a healthy development, these are a few of the matters that must be given attention. It seems to me this is another place in which a standing advisory committee on research could perform an invaluable service. There ought to be a closer co-operation between the heads of the research bureau of the Forest Service and the teachers and educators of our research men—in other words, between those that are acquainted with the administrative limitations and applications of research work and those that appreciate the purely scientific point of view. This closer co-operation should take the form of a standing committee consisting of professors of silviculture, the directors of the forest experiment stations, and the heads of the research bureau in Washington. If necessary, the advice of one or two professors of plant ecology should be solicited. A direct result of this closer co-operation should be the solution of the problem of how to give research men the greatest possible freedom in their work—how to divorce administrative work from research as far as possible under present administrative limitations.

Coming back to the question, Under present conditions of organization, how can Government research work be left relatively free and unhampered? While I have already made a few suggestions along this line, I am tempted to say something more about the top-heavy administrative organization of Forest Service research work.

The shackles of super-administration should be relentlessly withdrawn from the director of the Forest Experiment Station. He has original ideas, in most cases unbounded enthusiasm and initiative, yet what chance has he to put some of his ideas and hypotheses to a test? He wants certain equipment and desires to investigate certain problems; but these wants and desires must first be ground through the administrative mill of the district office and the Washington office. The man in charge of Forest Investigations at the district office, the assistant district forester in Silviculture, the district forester, the chief of Forest Investigations at Washington, the assistant forester in Research, and finally the Forester himself constitute the administrative mill. After the grinding process has been completed, what is left of the director's original ideas? It seems to me if the director is capable of running an experiment station, he certainly is deserving of more freedom and more confidence on the part of the higher officials than has been accorded him in the past. Even admitting that a certain amount of standardization and sifting-out of important problems is necessary in order to avoid duplication and other forms of wasted energy, the fact remains that this can still be done with about one-third of the overhead supervision that is today burdening the directors of the forest experiment stations.

This is another important question which should receive immediate attention at the hands of an advisory committee on forestry research, namely: How many and which of the present administrative officials are absolutely necessary to administrate the Forest Service experiment stations? The research work of the Government forest experiment stations of the near future, in my opinion, must be organized under a director and a staff of competent research men, with overhead administration reduced to a minimum.

The future interests of silvical and silvicultural research require a far-sighted policy—one which will lay the cornerstone of research for generations to come. To my way of thinking, state forest experiment stations connected with our state colleges afford the best means for putting such a policy into effect. Moreover, the general recognition of the rapidly increasing value to the public of state-supported research work points to the inauguration of state forest experiment stations on a large scale. State and federal money has been appropriated in the past for agricultural experiment stations and more recently for mines experiment stations, and a proposition for engineering experiment stations is under consideration. The ideal towards which we must work is a state forest experiment station connected with a state forest school in each important forest region of the country. If intensive forestry development demands it, one school and a station in connection with it should be organized in every State in the Union. These forest experiment stations will be in exactly the same relation to the forestry school as our present agricultural experiment stations are to the agricultural colleges. These forest experiment stations will be supported partly by the individual state and partly by the Government, and they will take up for solution in a thorough, scientific manner, under a director and a scientific staff, forestry problems which apply to state forests as well as to Government forests. In other details they will emulate the present excellent system of agricultural experiment stations in the United States.

Strange as it may seem, our agricultural stations are organized in the same manner as the forestry experiment stations I have already spoken of in Europe, India, and elsewhere. In 42 state agricultural experiment stations the office of the dean of agriculture and the director of the experiment station is combined in a single person. In 26 others the director of the station is an independent officer, reporting directly to the head of the agricultural college. This difference is due primarily to the fact that at some stations the number of duties and functions make two men necessary instead of one. In every case the close relation of the station with the educational institution is apparent, as well as the fact that overhead bureaucratic supervision has been reduced to a minimum. The experimenting staffs of these stations consist of from several to sometimes as many as 55 investigators. Most of them are are also professors at the agricultural colleges; all of them are specialists in their particular lines.

The co-ordination of research work with educational institutions has advantages which have been recognized for many years by scientific men all over the world. It has been common observation and experience that where a research organization is connected with a bureaucratic government organization research loses its freedom and independence because administrators lack the scientific point of view, and without knowledge of the needs of this class of work are not competent to handle appropriations for it. Appropriations are easily throttled and the work made to suffer in other ways. In our own Government service the research organization is top-heavy from an administrative standpoint. In the matters of improvements, personnel, and other work of the station the director has very little to say. Sometimes he is directly governed by a man in the district office who changes all the director's plans to suit his own ideas. Then, of course, the assistant district forester in silviculture and the district forester also have power to work out their ideas. In Washington there are two or three more officials and chiefs, namely, the assistant forester in research, the chief of forest investigations, and lastly the forester himself. If a plan or request, or whatever it may be, passes this array of officials, it is a miracle.

The advantages of co-ordinating the research work with the educational institutions are many. While under the other organization the work gradually becomes narrowed down to merely work in applied science, the fact that scientists and professors from the college or university have a hand in it brings in the purely scientific point of view. Not only does such work require field investigations, but laboratory, library, and academic leadership are important and often fundamental essentials. Research men must keep in touch with the literature of the subject and the progress of science. For these reasons the advantage of carrying on research work near an educational institution is apparent. Furthermore, one or two men cannot hope to master all sciences required in effective silvicultural research work. They must necessarily consult with plant physiologists, geologists, meteorologists, soil experts, pathologists, physicists, chemists, and others. This can be most effectively done when a station is connected with the university. In carrying on research it becomes absolutely necessary to gather together all the literature pertaining to each problem that has thus far accumulated, often in three or four different languages. This means first-class libraries, which are almost without exception connected with the great educational institutions and botanical centers. The outcome of research work to a large extent depends upon student habits, together with a research spirit and attitude which is rarely developed outside of academic influence. A research man must continue to acquire much of his preparation as he goes. A good library is therefore his greatest asset.

These, then, are some of the advantages of co-ordinating the research work with the educational institutions, and it is for these reasons that I believe that forestry research in this country will not receive the proper consideration until a number of state forest experiment stations have been established. Therefore no stone should be left unturned to encourage the establishment of these stations.

SUMMARY AND CONCLUSIONS

1. Research is an attitude and a spirit and is much deeper than experimentation. It is the process by which knowledge is advanced. The present war has emphasized the need of research. Progress in agriculture has been due to research. Forestry needs research in pure science to serve as a basis for applied science, which comes later.

2. The present investigative program of the Forest Service contains a large number of problems and large appropriations; but less than 25 per cent of both deal with real forestry. On the whole the problems treated are of a practical or applied nature rather than of a funda-

mental scientific nature. The great need is for a much larger percentage of men and appropriations for real forestry problems—those pertaining to silvics and silviculture—and more problems which seek fundamental scientific knowledge.

3. In order to give full recognition to research work, it is important that the forestry schools and the forestry departments of the nation and of the various states recognize the research type of forester and his peculiar qualifications and characteristics as distinct from the administrative type.

4. Only men of special training and the right temperament should be considered for research work. A thorough grounding in botany and other fundamental sciences is necessary. Judging from the botanical knowledge displayed by foresters in recent forestry literature, there is a great need for more and better botany courses in the forestry schools, not only for the use of those who are going to specialize in silvicultural research, but also to serve as a basis for sound practice and accurate literature. Not only must the forestry schools turn out properly equipped men, but the Forest Service should recognize the importance and need of such men and establish a position for them under the classified civil service.

5. Research men in Government service should be as free and unhampered as possible in their work. Administrative work should be relegated to administrative men and research men should give their entire time to their work.

6. State forest experiment stations should be encouraged in every way possible, because when co-ordinated with an agricultural college they represent the ideal manner of organization.

7. To give immediate recognition to the research needs of forestry, especially as pertaining to the solution of real forestry problems, there should be created a standing committee, to be known as "A Committee to Devise Ways and Means of Promoting Government and State Forestry Research of a Silvical and Silvicultural Character." This committee should consist of seven members, and might be selected by the Society of American Foresters from among their own ranks, as follows:

Two professors of silviculture of experience and reputation.
Two directors of Forest Service experiment stations.
The assistant forester in Research, United States Forest Service.
The chief of Forest Investigations, United States Forest Service.
One plant ecologist who has shown particular interest in forestry.

In addition to considering the suggestions made by Fernow, Moore, Clapp, Frothingham, Howe, Bates, and others, this committee should endeavor to reach an agreement concerning such questions as these: Which are the important and fundamental problems and which the minor ones? Which are most needed now and which can be delayed for solution? and What should be the logical order in which they should be taken up for solution?

In this connection it is interesting to note that the Society for Horticultural Science, in 1916, appointed such a committee on research and experimentation, which reported at the New York meeting of the American Association for the Advancement of Science in 1917. Dr. L. H. Bailey was the chairman of the committee. The report was divided into three parts: a definition of terms, the laying out of an experiment, and the training of an investigator.

The Forestry Branch of Canada has a committee such as has been proposed above. Its official title is "Advisory Committee to the Forestry Branch on Scientific Investigations." It consists of seven members, and a definite program of work was drawn up, which, however, has lagged on account of the war. Dr. C. D. Howe is the forest ecologist on this committee. The New York Section of the Society of American Foresters has a committee of five members on Forest Investigations, and they have already completed plans for the establishment of numerous sample plots in the Adirondack Mountains.

There is every reason to believe that a committee similar to the above-mentioned ones, whose duty it should be to establish definite Government and State policies pertaining to the prosecution of silvical and silvicultural research, and after that to lay down a definite plan of action, would lay the cornerstone for something better and bigger in the way of attacking our real forestry problems as they were defined by Dr. Fernow.

DEFORESTATION AND FLOODS IN NORTHERN CHINA[1]

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While in Tientsin during the months of November and December of 1917 I had the opportunity of going through the flooded sections of the city, and it was a terrible sight indeed! The boatmen who took us around through the flooded streets would indulge in pointing out to us the highest marks made by the flood water on the different walls, and also tell us that millions of natives were rendered homeless, that thousands had already perished, and that coffins were seen floating in the flooded area. The country which was under crop ready for the harvest is now a great inland sea with boats plying between points or islands formed by rising ground. The damage that has been done to crops and houses, the loss caused by stoppage of trade, interruption of railway traffic on the Peking-Hankow and the Tientsin-Pukow railways—this has been estimated at hundreds of millions of dollars. It is further estimated that in the city of Tientsin alone there are more than 120,000 flood sufferers; but, thank goodness, most of these sufferers are being properly taken care of by different organizations, and for their shelter thousands of mud huts have been put up.

According to the latest report of the general relief committee, which gives detailed information of each of the hsien that has suffered from the floods, we learn that there are altgether 103 hsien or 17,646 villages affected by the floods, and that in these hsien there are as many as 5,611,759 sufferers who are either homeless or starving.

When we come to think of prosperous and peaceful Switzerland as having a population of only 3,425,000 and an area of 15,975 square miles as compared with 5,611,759 sufferers and 15,000 square miles of flooded districts here, we at once comprehend the severity and the extent of devastation by the floods; and it is no wonder that they have been called phenomenal floods or something that Chihli province has not experienced for the last 170 years.

[1] This article, written for the English reading public, contains the substance of a pamphlet written in Chinese by the same author during his recent investigation trip north. The article was reviewed by Prof. J. W. Toumey in the May issue of the Journal.

Actually to see the results of such record floods is no more interesting than to learn of what some people have said as to the real cause of such floods. So before I discuss the problem from a purely forestry standpoint, I wish to quote at the outset what some of the engineers or scientists who have been for some time connected with Chihli conservancy work have said.

Mr. J. B. Taylor, in his attempt to arouse the people in Chihli to the necessity of inaugurating a permanent Chihli Conservancy Board, suggested among other things that reforestation is the most important remedial measure which must be taken in the control of Chihli floods, and he emphasized the point by saying:

"It is absolutely essential to ameliorate the rivers, especially the Hun Ho, in the mountainous collecting basin, by reforestation and by the erection of barrages. The first effect of this is to delay the waters during heavy rains and so reduce the freshets and the liability to floods. But these improvements have a much more important effect, namely, the keeping back of the silt which is so injurious to the rivers. Forests act as a sponge, retaining moisture and furnishing a protective coating that prevents erosion."

Mr. P. L. Yang, chief hydraulic engineer of the Conservancy Bureau, Ministry of Agriculture and Commerce, in his study of the river system in Chihli, wrote:

"There are three ways of solving the flood problem in Chihli, namely: (1) reforestation; (2) erection of barrages; and (3) construction of reservoirs. But the erection of barrages and the construction of reservoirs require such an enormous expenditure of money, and besides they do not have a permanent effect. So we may safely say that reforestation is the best and the most important measure to be considered in the control of floods in Chihli province."

Again, Dr. P. E. Licent, a well-known scientist, who conducted perhaps more scientific investigation through the flooded districts than anybody else, said:

"It is to be feared that next fall there will be another big flood around Tientsin, because the five rivers in this province are badly silted up and the embankments are in bad repair. For instance, along the Tze-ya Ho from Sienhsien to Tientsin, I saw twelve places at which the embankments are broken. Now it is on account of a long-continued deforestation which has deprived the different watersheds of their protective covering that all these rivers have become silted up. I was traveling in the mountains near Paotingfu last August, and I saw hundreds of corpses washed down with houses, dead cattle, bowlders, etc., by the terrific torrents. In one place called Tai Lun Mung, near Chochow, I saw eighty four corpses floating gruesomely on a little pond. The terrible mountain torrents must have been responsible for such a state of affairs. China cannot hope to harness her water or regulate her streams until these torrents are stopped, and to stop them permanently a systematic program of reforestation similar to that in our country must be carried out."

Then, again, Mr. T. Pincione, engineer-in-chief of the Hai Ho Conservancy Bureau, observed:

"Providing a sufficient outlet to sea of rain water is essential, but the only way to cure the evil of the quick inrush of freshets is to arrest in the mountainous regions the sand which causes the silting up of different channels to the sea. It is said that forests can hold on nearly 50 per cent of rain water, so forests by reducing the capacity of channels by 50 per cent will greatly regulate the downflow of water.

"The Chihli rivers during freshets have an output from 150 to 200 times the output during dry seasons. For instance, the Yung-ting Ho or Hun Ho in dry season has an output of scarcely 1,500 cubic feet of water per second, but during freshets its output rises to 200,000 cubic feet per second. It is evident that if a channel is prepared for this large output it will silt up during dry seasons on account of the meager supply of water. On the other hand, if the channel is good for 1,500 cubic feet, it cannot carry down to the sea 200,000 cubic feet during rainy seasons. Only reforestation is able to prevent this great difference of output, holding on nearly one-half of the rainfall during the heavy rains, and giving it subsequently to the channel. Therefore forests can be compared to a sponge for retaining rainfall and giving it up gradually. Then also we must consider that the vapor from the sea when encountering with forests is bound to condense and restitute to the sea the water taken, with a process more uniform than would take place on the bare mountains.

"Therefore, in my opinion, reforestation is absolutely indispensable for the proper regulation of rainfall and the improvement of the channels carrying the water back to the sea."

Perhaps the most convincing account of the need of reforestation in the regulation of Chihli floods is that by Mr. H. Vander Veen, C. E., who has been for many years consulting engineer to the Natural Conservancy Bureau in Peking. At the conclusion of one of his recent reports he wrote as follows:

"I have dealt in the foregoing pages with the causes of the frequent floods in the Chihli province and have endeavored to explain how the conditions can be improved by providing a sufficient outlet for the flood water. But with that the danger of floods has not been removed altogether, for there remains still the difficult problem to settle what to do with the quantities of silt which the river could not bring down to the sea, notwithstanding the improved outlet.

"As long as the slope of the water level is such that a current can be maintained strong enough to carry all the matter held in suspension along, no harm is done. But, as I explained in the beginning of this report, the natural slope of the plain is, for several rivers, insufficient. In such a case the river is therefore forced to get rid of the soil, held in suspension, along its way, consequently its bed gets raised and in the long run the river has to find another course, which it does by bursting its dikes to find in the lower lying land the place where it can deposit its burden, which it could carry no longer and for which no more room could be found in the old bed. This is the case more or less with every river running through the plain of China.

"The only way to diminish this evil is to diminish the amount of soil brought down from the mountains. And the reason for this enormous quantity of silt coming down from the mountains is that those mountains are bare, so that during a heavy rain nothing prevents the water from rushing downward practically immediately after it has fallen, taking with it large quantities of soil, so that it reaches the river down below more like torrents of mud than of water. Now if those mountains were planted with trees not only then would the water be unable to take away so much soil, but it would also reach the river gradually in a regular flow divided over a longer period and not within a few hours in fierce torrents.

"It is impossible, therefore, as I have said on several former occasions, but I wish to repeat it again, to lay too much stress upon the enormous importance of reafforestation. The deterioration of the various rivers in China, and specially of those in this province, would never have reached its present stage if deforestation had not taken place. I say specially the rivers in this province because they all take their rise in the mountains west of the Peking-Hankow line, which for a great part consist of loess, a soil which is easily carried away by the rain.

"To build reservoirs in the hills in order to regulate the flow of the water, as has sometimes been suggested, is not only far too expensive, but, moreover, wrong, as it does not do away with the problem of silt. Sooner or later these reservoirs would become filled; consequently new ones would have to be built, a process which would have to be carried on into eternity.

"Reafforestation is most imperative, for without reafforestation the improvement of rivers can only be partly accomplished, but all these processes going hand in hand, the improvement of the hydraulic conditions of the country will be decisive."

The foregoing statements as to the importance of reforestation are made by prominent engineers or men who have been closely identified with the conservancy work in Chihli. These men are not foresters, but the fact that they have repeatedly emphasized forestry shows conclusively how the problem of flood in Chihli—yes, in all China—can never be *permanently* solved unless a systematic program of reforestation is carried out together with the hydraulic engineering works. As a forester, I wish to show what has already been written about the relation of forests to floods and to bring out how different elements come into play to make this relation so close. It is hoped that the information thus set forth will help my readers to understand and appreciate better the importance of tree-planting in the regulation of stream-flow and in the control of destructive waters.

For the sake of clearness we shall first discuss the effect of forests on floods under the following heads:

1. Forests and stream-flow.
2. Forests and soil erosion.
3. Forests and floods.

1. *Forests and Stream-flow.*—It has been proved that the effect of forests upon streams in level countries is unimportant, but in hilly and mountainous countries they are conservers of water and tend to maintain a steady flow of water in the streams.

In the mountains the greatest loss of rain water is through surface run-off (water that washes off the surface of the ground); and the most important influence of a forest cover is in reducing this. It is stated that the amount of water saved in this way by the forest is 20 per cent to 35 per cent, and often more with higher altitudes.

The reasons why the forest is able to check surface run-off and save portions of it to the soil are, first, the trunks and the underbrush in the forest offer mechanical obstruction; second, the litter of the forest floor checks rapid surface drainage of the water and also acts as a sponge; and, third, the network of deeply penetrated roots, living and decayed, make the forest soil more porous and permeable; hence the water sinks into it more readily.

It is evident that the ability of the forest to check surface run-off is greatest when the forest is dense and when the ground beneath it is covered with an unbroken leaf litter.

It must be borne in mind, however, that when water is precipitated from the clouds, a portion of it is prevented from reaching the ground through interception by the leaves, branches, and trunks of the trees. This intercepted portion varies according to the tree species and the density of the woods. According to Bavarian investigations, it averages 23 per cent of the total rainfall. So, after a rain, we often find that water continues to drip from the leaves and twigs for hours.

With this knowledge of the different factors which tend to influence the amount and the rapidity of running water in forest-clad watersheds, we are in a position to understand the relation of forests to stream-flow.

In forested regions, rain-water is conserved in such a way that it is allowed to drip slowly down. So we find that in such regions streams do not rise high immediately after rains and do not dry up when there is no rain, and there is always a great abundance of springs which go to feed such streams. Forests and forest soil are like large reservoirs for the conservation of rain-water for stream-flow.

Forests regulate stream-flow by conserving not only water, but also snow. That forests retard the melting of snow has been demonstrated in a series of observations carried on at Moscow. Results show that the period of snow melting within forests is from 26 to 57 days, while snow in the open disappears within six or seven days. The ability of the forest to retard the melting of snow is due chiefly to the shade and protection given by the trees and the underbrush, and each gradual thawing (this would be the case if the mountains in North China climate were well wooded) will render it possible for streams to be slowly fed; hence a more even stream-flow.

II. *Forests and Soil Erosion.*—When water rushes down a bare slope it possesses great mechanical power. It loosens the soil and carries it downhill. It makes gullies and ravines and causes land-slips. The soil brought down not only renders the fertile land below valueless, but also, as brought out in previous paragraphs, goes to the silting up of streams.

It is generally understood, however, that of all the vegetable covers, forests are most efficient in protecting slopes from the erosive action of water. This is because, first, the roots of the trees hold the soil firmly in place and so increase its resistance to erosive action; second, the crowns of the trees protect the earth from the violence of beating rain and intercept a considerable portion of it; and, third, the velocity of the moving water is checked, because of the reduced amount of the run-off; hence the erosive force of the run-off itself is minimized. On the whole we may say that on a forested slope a series of obstacles is always present to oppose the movement of the water and reduce its velocity and force, and consequently its erosive action.

The importance of a forest as an effective agency for protecting the soil from erosion has been recognized for centuries in Europe. The so-called "protection forests" in France, Switzerland, and Austria were created with the express purpose of protecting mountains and hills and of preventing communities from being impoverished by floods and torrents which destroy and silt over fertile lands at the foot of the mountains. History has shown time and again that wherever extensive deforestation has taken place the consequence has been the gradual formation of a series of torrents, the abandonment of farms, the rapid silting up of river channels, and frequent visitations by floods. To remedy these evils great efforts have to be made to reafforest the denuded areas. France has experienced this, and millions of dollars have been spent in the work of reforestation.

III. *Forests and Floods.*—From their relation to stream-flow and soil erosion, we can readily see the relation of forests to floods. On all denuded mountains a heavy rain is generally followed by the formation of a system of gullies. These gullies begin a short distance below the divide and then form lines of least resistance to the passage of water. As these gullies or furrows extend down the slope they join neighboring furrows and become rapidly wider and deeper until large gullies of many feet deep are formed. Where hills are thoroughly drained by a system of gullies, the water from a storm will sweep down through them in a fraction of the time that would be required if it had to trickle down in a thin sheet or amidst vegetable obstacles. Now if the main channel is unable to discharge the influx of water as fast as it rushes down, the result is a flood.

The high rate of run-off, which is characteristic of streams arising from denuded hills and mountains, enables them to carry an enormous amount of silt and bowlders of extraordinary size. The transporting power of water varies as the sixth power of its velocity, so that if the velocity of a stream is increased ten times, for instance, its transporting power is increased 1,000,000 times. This is why, in the case of Chihli rivers, they speak of stones and bowlders of large sizes carried down to the foot of mountains and of the enormous quantity of silt brought down to raise the beds that have already been silted up.

With this general knowledge of the relation of forests to stream-flow, to soil erosion, and to flood waters, we are in a position now to appreciate better the statements made by the engineers and to understand why they all should have emphasized the importance of reforestation as an indispensable supplement to their hydraulic works.

The river system in Chihli, with which we are concerned, may be briefly said to consist of the Pei-yun Ho, the Yung-ting Ho, the Ta-ching Ho, the Dze-ya Ho, and the Yu Ho. The first four of these rivers have upland collecting basins in the mountains to the west of Chihli and in Shansi, while the Yu Ho, or Grand Canal, receives all the water from the Wei Ho, a river rising in the western hills of Honan. These five waterways drain altogether a basin of 75,000 square miles, and of these about 60,000 square miles are mountainous. The five rivers have, as a matter of fact, only one outlet—that is, the Hai Ho. The maximum capacity of the Hai Ho is 30,000 to 35,000 cubic feet of water per second, but, as has been brought out before, the Yung-ting Ho alone carries down as much as 200,000 cubic feet per second during summer freshets. It is evident then that all the water that comes down in excess of the volume disposed of by the Hai Ho must necessarily overflow and become flood water on every side. It requires very little imagination to picture to ourselves the enormous amount of water that the 60,000 square miles of deforested mountains and hills must shed during torrential rains, and then to think further how the water rushes down the hillsides, unhindered by vegetation, making gullies and carrying with it enormous amounts of silt. If any of our readers had seen the flow of the Hai Ho, he could not have helped comparing it to the flow of liquid mud. Since the Hai Ho cannot discharge such an influx of heavily laden water, the only alternative will be for the water to break through the embankments and overflow the surrounding country; hence we hear of 5,611,759 people rendered homeless and 17,646 villages partly or wholly under water.

It is obvious, therefore, that provision must be made for adequate outlet to the sea for the five streams, and until this is done inundations are bound to occur regularly every year.

But, granting that a more adequate outlet to the sea has been effected—which we know is a prodigious engineering task—are we going to consider the problem of flood in Chihli as solved? What about the silt problem? Can it be taken care of *permanently* by barrages, reservoirs, weirs, dikes, outlets, and other engineering works? Will not the reservoirs, outlets, etc., be silted up again after a few years of usefulness, just as the different streams have been silted up? Have we not heard that at some places the bed of the Yung-ting Ho is 20 feet higher than the adjacent country? What about the torrential run-off? Can it be permanently checked, harnessed, and conserved for commerce and navigation and for the use of millions of agricultural people who have year after year suffered from either drought or famine? One could go on and ask countless questions of such character, but suffice it to say that though engineering works are all necessary remedial measures, they are not sufficient by themselves, and unless they are supplemented by reforestation at the sources of the different rivers their effect can only be *temporary*.

The problem of flood in Chihli, therefore, is fundamentally a forest problem. A systematic program of reforestation will have to be carried out before the problem of silt, the problem of unrestrained run-off of rainfall, and the problem of reservoirs, of dikes and outlets, can be permanently solved.

It must be remembered, however, that China is not the only country where floods occur. History has shown that all countries have experienced floods. In fact, floods have always played the rôle of a sounding bell to nations that have not paid enough attention to the proper handling of forest lands or lands that are not fit for agriculture. The creation of "protection forests" in different European countries was but the result of an effort put forth by people who suffered from floods and who wanted to stop their recurrence. France has perhaps furnished the best example, showing where reforestation has been undertaken on a large scale to reclaim waste lands in order to regulate stream-flow and to stop floods. It might be well for us at this time to turn to history to see how, before the Revolution, the mountains in the Vosges and the Jura Alps in France were protected and no clearing was allowed. But during the Revolution restriction vanished and ruthless cutting began. Cutting, forest fires, etc., went on until millions of acres of land were rendered useless on account of torrents doing great damage, inundating plains, tearing away fertile lands, and silting up rivers. This went on until Surell, in 1841, made a special study of the regions, and in his "Etude sur les Torrents" he called the attention of the people to the relation of forests to torrents and emphasized the need of tackling the problem at the sources. Then work was started, but it was not until 1882, when the Reboisement Law was passed, that systematic work was taken up. The work is still going on and millions of dollars have been spent already, but it is estimated that many more millions will have to be spent to complete the work. Now what has been the result? It is said that of the 1,462 torrents, 163 are entirely controlled, and about 650 have begun to be "cured." It is also said that among the 163 that are controlled are 31 which 50 years ago were considered by engineers as incurable.

France, then, like every other country, has had a sad forestry story to tell; but doubtless such experiences as she had are invaluable and should be an object-lesson to us at this time.

It is hoped, therefore, that our country will soon realize that want, loss, and misery are inevitable results of a long-continued deforestation, and that this may act as a spur to wake her up to do something to start this all-important work—forestry. We have not mentioned here the direct benefits that China will derive from practicing forestry, but let it be sufficient to say that forestry and agriculture are the greatest of all industries, and that unless both of them are developed China cannot hope to utilize fully her greatest of all resources—the land. It is hoped that all well-wishers of China, and especially the engineers who have worked so assiduously to improve the hydraulic conditions in this country, will co-operate to bring this message to our officials and gentry, *that the problem of flood in the north cannot be permanently solved until the different watersheds are properly clothed with trees and protected.*

SILVICAL SYSTEMS IN SPRUCE IN NORTHERN NEW HAMPSHIRE

By Edward R. Linn, M. F.

Forester for Brown Company

In northern New Hampshire the forest fires are so well controlled that today the losses are very small. The good work of the New Hampshire Timberland Owners' Association, in co-operation with the State Forest Service, stands out as a shining example of what can be done to keep fire out of the woods.

The problem of second growth in New Hampshire is easily next to the fire problem in importance. How to operate timber lands to obtain second growth, keeping in mind the fact that the operator is in a competitive business, is a problem that has puzzled and is still puzzling the timber-land operator who operates on a large scale in New Hampshire and Maine. Various systems of management have been tried with many different results. The selection system has been recommended, tried, and given up for one reason or another. Several modifications of the selection system—clean cutting in strips—and the group system have all been tested out. The market or economic conditions militate against these systems. There are very few logging railroads, the logs or pulpwood are driven to the mills, and consequently in the back regions hardwood is not merchantable.

In the following pages it is proposed to record the results of various methods of cutting, mostly done on the Brown Company's territory.

In the last 30 years some of the operators in northern New Hampshire and Maine have tried cutting spruce following the various silvical systems. The most popular method of cutting that has been in vogue is cutting to a diameter limit, a modification of the selection system. This system has been applied to all types of spruce growth with all kinds of results. In the early days, when only the piano butts were taken, the selection system in the pure spruce types seemed to work as it should. In the hardwood type I doubt if anything happened save to reduce the percentage of spruce in that particular forest type. Some diameter limit cuttings of spruce and fir made in New Hampshire from 10 to 25 years ago leaves the forest today in the following various described conditions:

DEAD DIAMOND RIVER

Hardwood Type—Diameter Limit, 12 to 14 Inches on the Stump. Cut 1889 to 1911

The effect of cutting to a dimeter limit of 12 to 14 inches in the hardwood type has been gradually to turn the forest into an ultimate hardwood stand. For example, the cuttings on the Main Dead Diamon River, near Hell's Gate, in 1897 to 1899, have changed the composition of the hardwood type only in so far as it has reduced the per cent of spruce and fir. The larger trees that were suitable for sawlogs were taken out, leaving the suppressed spruce and the fir of smaller diameter.

Several different results were noted:

The openings in crown cover were taken up by the crowns of the surrounding hardwoods, or else came in to young hardwoods, or were taken up with fir reproduction, which is making a fair growth when it has a chance, but in many places will never make large trees, as the light will be shut off by the surrounding hardwoods.

Where just one tree was removed the change wrought consisted only in the absence of the spruce. However, where 6 to 10 trees on a quarter acre were removed, enough light was furnished to enable fir to start, and some small clumps of second growth of this species will be found in the future. Probably the best illustration of this last condition was found in some cuttings about 40 years old. Here are found clumps of second growth fir 6 to 10 inches in diameter, 30 to 60 years old. Testing with an increment borer revealed the fact that the 60-year-old trees were suppressed for 20 years, and had then not attained a diameter of over an inch at breast height. When the older spruces were removed these suppressed trees were able to grow more vigorously, and the annual rings put on compared favorably with those of the other trees in the group that started from seed after the cutting was made. In short, suppressed fir, 20 to 25 years of age and not over 6 to 7 feet high, revived and took on vigorous growth, besides fir seedlings started after the old trees were removed. The resulting trees are practically of the same volume today.

In the more recent cuttings, made 10 to 15 years ago, the same result was noted, namely, fir filling in open spaces in the hardwoods where proper conditions of light and seed bed were present. These latter spots were not such good illustrations of final results, however, because the fir has attained as yet only a height of 8 to 14 feet and d. b. h. of 1 to 3 inches.

Where, then, just one or two trees had been removed there was no result other than making more room for the surrounding hardwoods. Occasionally young fir trees were present, but even where no older trees were removed there was found young spruce and fir coming up under the hardwood. That these trees will ultimately make sizable timber is questionable. At least they will not do so in the length of time that one would care to spare for a rotation.

In many places where the spruce and fir had been removed the slight openings were being filled in by hardwood reproduction or by brush of the mountain maple or striped maple. This is very noticeable on the hardwood ridges. They are surely being changed into a pure hardwood stand.

Throughout the hardwood type there is a very scattering reproduction of spruce and fir, consisting of stunted trees 3 to 6 feet high, with flat, bushy tops. They are 20 to 40 years of age and will never make timber unless the hardwood is cut.

Spruce Slope Type

Briefly described, this type occupies steep, rocky slopes with thin soils. The soil is practically lacking, thick deposits of moss and duff hire functioning as soil. Spruce and balsam make up the greater per cent of the stand, with spruce up to 75 per cent of the total. This type was found only on a few small knolls or outcrops of rock. Very little of the country where this study was made is in the spruce slope type. In these places the trees were still standing. The logging of 15 years ago did not include them, possibly because of their undersize or because of the difficulty of logging as compared with other areas. However, this type was studied for reproduction, and the following conditions were noted:

1. Enough reproduction covered the ground to restock the land in most instances. In some places it might be advisable to leave seed trees, expecting that they would blow down, but hoping that they would accomplish at least part of their function before being wind-thrown.

2. The reproduction was heavier in per cent of fir than the old stand.

3. Where cut into slightly, these knolls, or where the type might be said to verge into the spruce flat type, the reproduction was thriving and almost too dense to be good.

On the north side of the Little Dead Diamond River, on lots 12 and 14, cut 1899 to 1905, pure spruce is found on the gently sloping land, but merges into a mixture of hardwood and spruce nearer the height of land. Here a diameter limit of 12 to 14 inches was followed, but because of the uniformity of the growth the area was practically cleaned, leaving only scattered clumps of spruce two or three in a clump or sometimes single trees.

The result of the operation is that no excessive windfall was noted and reproduction of spruce and fir covers the ground. The greater number is of one age class, namely, an average of 15 years, with about 2 to 3 inches in diameter and 16 feet high. The height growth in the last three years in fir averaged 14 inches, while in spruce the growth is somewhat less. Besides this more or less even-aged class, there is reproduction from 12 feet high down to one-year-old seedlings. About 75 per cent of the new growth is fir. Reproduction is ample; in fact, in a few years the trees will feel the effects of being crowded.

Here, in this particular site, the soil was fairly deep and the few remaining large trees were not wind-thrown.

This plot is an example of good silviculture, excepting that too many trees were left for seed.

Spruce Flat, 12-inch Diameter Limit, Cut 1906

West of McKeen's Falls, on the Dead Diamond River, is a representation of this type. Cut to a diameter limit of 12 inches about 10 or 11 years ago, there are now standing a good many trees from 6 to 10 inches in diameter, while the ground is covered with reproduction 6 to 10 feet high. Windfall is taking some of the old trees, but as a whole the site is protected. The present stand might cut two or three cords to the acre. It would be murdering the reproduction to go in and cut the older trees unless extreme care was taken. The cost of logging the remaining stand would be increased by the small cut per acre obtainable. Fewer seed trees would have served as well for reproduction if any were needed.

A saving in the cost of logging, by taking more trees and ignoring the rigid diameter limit, might have been made, for more lumber per acre could have been cut. If the stand is entered now, much reproduction will be destroyed, and if the stand is not entered, the old trees will be wind-thrown or die before the second crop is ready for cutting.

The reproduction is mostly fir 6 to 15 feet high, coming in under a scattering of spruce 6 to 10 inches in diameter. The crowns of the spruce are small and the growth is slow. The trees are over 100 years old and no increased growth was found by testing with the increment borer.

CUTTING TO A TEN-INCH DIAMETER LIMIT

In the town of Grafton, Maine, at the head of the Cambridge River, cuttings were made to a 10-inch limit. The growth was a spruce flat that merged into the hardwood type. Here the soil is thin and rocky, and the wind makes a good sweep when it blows. In cutting this area large clumps of trees that were small were left intact and single trees in the other parts were left standing alone. The result, then, is that the isolated trees were practically all blown down, and the wind is slowly but surely taking down the clumps by systematically tipping over the trees on the edges. It is somewhat difficult to say much about reproduction, for the areas have been entered in some places several years ago in an effort to pick up the "blow-down" and rescue what remained standing. This season the remaining portion of the area is to be cut over for rough wood. It is needless to say that it costs money to pick up blown-down timber and to log in scattered timber. A lot of the "blow-down" is beginning to decay, and so is spoiled for pulp or lumber. The reproduction, where the area was cut quite clean, has a good percentage of spruce in it, but the greater percentage is fir.

ABBOTT BROOK

Hardwood Type

Along the Dartmouth College Grant line, about one-fourth to one-half mile from the State line, the following conditions were noted: The academy grant was cut to a 14-inch limit about 25 years ago. Across the line, at this particular spot, the college grant runs about 20 cords to the acre. The growth is large red spruce, up to 16, 18, and 22 inches d. b. h. The reproduction of spruce under these old trees seems ample to restock the spots. On the academy side of the line, where the old spruce growth was removed, but where the conditions were practically the same, as evidenced by the numerous stumps, the ground is now occupied by beech and birch saplings 1 to 3 inches in diameter and 20 feet high, growing in a dense stand. A few young firs were mixed in. Here the land did not come in to spruce, though spruce trees were everywhere present.

In many places in the hardwood type in the Abbott Brook Valley, where the cutting was to a 14-inch limit, the underbrush of mountain maple and striped maple is so dense that road swamping will be very expensive when the loggers come back after the spruce in the scattering stands.

In other places the stand of hardwood is almost pure. Again, in other places, fir second growth is filling in the slight openings made by removing the spruce (1890-1892), the fir being 6 to 10 inches in diameter. In other sites young birch is filling in the gaps.

Spruce Flat Type

On both sides of the Brook the spruce flat type occupies the ground, forming a strip from several rods wide to half a mile in width. The soil here is thin, thickly strewn with rocks, and a heavy growth of moss covers all. This region was cut in 1890 to 1892 to an approximate limit of 12 to 14 inches, with the following results: The larger trees being taken, the remainder, with scattering exceptions, were blown down, as evidenced by row after row of moss-covered, rotting trees. The reproduction is mostly fir, with a good per cent of spruce. The diameters vary from 2 to 4 inches, and the height 16 to 25 feet. It is spaced so closely that travel through it is difficult. The density is inimical to growth. Under a clump of older spruce that was still standing, the reproduction was dense, but it varied in height from a few inches to 6 feet, thus showing that lack of overhead light and root competition with mature trees interfered with growth.

The loss of the big trees that were blown down makes logging of the few remaining unprofitable, and the reproduction is too dense. It would have been better to cut clean and, if there was not enough reproduction on the ground, to leave a few seed trees, expecting them to blow down. However, I believe that there is, as a rule, enough reproduction already started to restock the land after cutting. In some cases seed trees should be left, and those cases should be decided upon by a man who is skilled in marking.

CLEAN CUTTING [1]

Around Lincoln Pond, in Parkertown, Maine, pulpwood was peeled in 1899-1902. The area is a typical spruce flat with rocky, moist soil. The tree growth was not extremely large, but the stand of spruce was dense. Some cedar, white birch, yellow birch, and maple is still present. The area peeled is oval in shape, 2 by 3 miles, with the pond in the center. Here all the trees were taken. All that remains of the old growth are a few scattering hardwoods, which are dying, and a few very much stunted and suppressed spruces 3 to 4 inches in diameter and 10 to 20 feet high, having that peculiar flat, umbrella crown noticeable in extremely slow growing, suppressed spruce and fir. Although these

[1] Study made in 1916.

trees have had plenty of light for the last 15 years, they have made no appreciable increased growth. On a few the leaders are beginning to lengthen out, and this year's growth is probably 6 inches. However, the majority are hanging on to life. Some of these trees are 75 to 100 years old.

Keeping in mind the fact that the area cut is 2 by 3 miles and that the trees were all taken excepting very small suppressed trees that were not capable of reseeding the area, yet we have the ground covered with reproduction of spruce and fir.

The new growth is 40 per cent spruce and 60 per cent fir. The trees are about 14 to 15 years old; the fir 12 to 14 feet high and the spruce 8 to 10 feet high. Some of the fir trees measured 4 inches in diameter at the collar, 17 feet high, 17 years old, and showed eight rings to the inch at d. b. h. Spruce is 4 inches in diameter at the collar, 13 feet high, and 17 years old. The main portion of the new reproduction, however, averages somewhat less in height, but the age class is a fairly uniform one of 14 to 17 years. This reproduction is on the ground only where roads were not made. In peeling and hauling short wood, numerous roads are made. However, here could be traced the old main roads and many of the lesser roads. Spruce and fir growth was dense at the sides of the roads, but there was none in the roads.

It appears, then, that unless seed trees were on the area, since the area is fairly evenly stocked and is too large to be seeded in from the sides and no growth is in the roads, the reproduction must have been present at the time of cutting.

REPRODUCTION OF SOFTWOODS IN THE HARDWOOD TYPE

At least 50 per cent of northern New Hampshire is in the hardwood type—that is, softwood is mixed with hardwood, but the hardwood is present in greater porportion than the softwood.

Usually just the softwood is cut and the resulting reproduction is as described in the foregoing pages. Some areas where the hardwoods were cut, too, were visited in order to study the resulting reproduction.

Hardwood Cuttings in Dummer, N. H.

One concern has for the last six years been operating in Dummer, cutting hardwoods and any softwoods that may have been left. Most of the spruce was cut for logs a number of years ago, but there was left a scattering of small spruce and fir, 6 to 10 inches in diameter, as was evidenced by the numerous softwood skids in the log-hauling roads.

In what formerly was a hardwood stand, the ground is now covered with raspberry and maple brush, but interspersed through this is found some fir that is overtopping the brush; also, throughout the raspberry growth, young fir is coming through with 6-inch leaders for this year's growth. These undoubtedly will overtop the brush. The reproduction in this hardwood type is not as dense as desirable, but is much denser than where the hardwoods are left standing.

On the areas where the spruce and hardwoods were mixed, containing 30 per cent or more softwoods, the reproduction is good and a fair percentage of the new growth will be softwood. Perhaps it will not be as rich in softwood as was the original stand, but the resulting forest will be hardwoods, fir, and spruce and not almost pure hardwoods, as in regions where the spruce and fir only were removed.

Cordwood Cuttings—Cates Hill, Berlin, N. H.

About seven years ago the cordwood and softwood on Cates Hill was cut at the same time. Result: Scattered through the open spaces, where the light is good, young fir 3 to 6 feet in height can be seen pushing through the brush. As in the case of the other lands described, where the hardwoods have been removed, the reproduction of fir, while not completely taking over the land, is coming in very well, and the future growth will be a mixed forest.

FACTORS INLUENCING TREE GROWTH

Why the spruce and fir reproduction comes in and thrives on hardwood lands that have been logged over for both softwoods and hardwoods better than on lands that have been logged only for softwood depends on several factors, not the least being the changed light conditions. Zon and Graves, in Bulletin 92, Forest Service, make some pertinent statements under the title "Factors Influencing Tree Growth."

"Tolerance varies not only with species, but even within the same species, according to conditions under which the tree is growing. These variations are due largely to changes in the structure of the leaves, brought about by changes in transpiration. Among the important factors influencing transpiration, and therefore tolerance, are climate, altitude, moisture, and nourishment in the soil, age of tree, and vigor and origin of the individual.

"Plants need less light the higher the temperature and more light the lower the temperature. Consequently, the higher the temperature of a given locality the more shade a tree can stand."

The above applies to mature trees in different regions, but it can be applied to reproduction locally as well. The shading of the ground by raspberry and other brush is often very dense, and the light is perhaps not so good as in a high forest, yet the heat intensity is greater, for the sun's rays strike the brush a foot or two above the young seedling, while in the high forest the heat is mainly absorbed by the mature trees many feet above the little seedlings.

"Trees with a strongly developed superficial root system naturally desiccate the upper layers of the soil much more than trees with a compact, deep root system."

It naturally follows that if both softwoods and hardwoods are removed the young seedlings have only the brush to compete with for the moisture. To quote further:

. . . "the so-called 'light increment,' or increase of growth after logging or thinning, is not due alone to the great access of light to the remaining trees. By thinning a stand not only are the light conditions changed, but the competition of the roots is diminished, which leads to an increase of moisture in the soil. The leaf litter is also more rapidly decomposed, and the soil in this way becomes enriched with nutritive substances, all of which results, of course, in an acceleration of growth after thinning."

In the foregoing discussion very little has been said about increased growth of the trees left through following a diameter limit when logging. The theory of the diameter limit is that one aims to select trees for cutting on a basis of age; in actual practice in this locality the cutting was based on size.

DEFECTS OF A RIGID DIAMETER LIMIT

A rigid diameter limit presupposes a normal selection forest. As a matter of fact, there is often a deficiency of thrifty trees just below the diameter limit capable of growth, and not uncommonly a large number of these are cut for skids, bridges, and other purposes in logging the mature timber. The idea of the diameter limit is that the medium-sized trees will take on growth, but elsewhere in this discussion it has been shown that the growth did not increase as it was supposed to. Moreover, no provision is made for the care of the reproduction. The loggers often injure a large amount of it through carelessness. In many instances in hardwood stands the removal of spruce leaves the reproduction and the small-sized spruce still shaded.

Formerly, when only large trees were merchantable, there was little temptation to cut small timber, but under present conditions, with pulpwood at a premium, a 12-inch diameter limit on the stump means a 10-inch limit under the old régime of ax-cut trees and high stumps.

Most of the diameter-limit cuttings have been based on guesswork. Some one thought, or hoped, that a 12 or 14 inch limit would give a sustained yield, and then the loggers cut as they pleased. The result of the diameter-limit cutting is that many large corporations are hunting for timber lands in other localities to help supply the mills, because their present holdings do not yield as they were supposed to.

Following is a quotation from a letter from Prof. R. C. Hawley, of the Yale Forest School:

. . . "I should divide the northern country into hardwood land and softwood land, the former being mixed stands of hardwood and softwood. The fact that hardwoods are maintaining themselves in the virgin forest in competition with the softwoods indicates that the latter cannot reproduce abundantly on this type of land. A selection cutting to 12 or 14 inches leaves so few softwoods that a second cut in 20 years hardly pays, and, furthermore, provides too few seed trees to get reproduction. On this land one of two things seems advisable: either cut to the lowest merchantable limit or leave all the softwood standing. This last scheme is being tried at Nehasane[2] Park in the second cutting, which they are now carrying on under a forester's supervision. They secured very little reproduction on hardwood land after the first cutting. Here, however, they combine the plan with the cutting of all the hardwoods that are salable. It leaves plenty of softwood for the next cut and for seed. The logging of the hardwoods tears up the litter considerably and gives a better chance for softwood to start than existed before the cutting. Where you cannot cut the hardwoods, I think it is an absolutely hopeless proposition to get an increase of softwoods in the future forest. Why not get the softwood out entirely and expect a hardwood stand? You never can make the land really productive, once the virgin softwood is cut, until the hardwoods are salable. Then they can be removed to make way for conifers or grown as the desired crop.

"Another point against a selection cutting of spruce on hardwood land is that the trees you naturally leave below the limit are all of them suppressed trees and standing still in growth. Unless the hardwoods die or are cut these suppressed trees will continue to stand still. In other words, your investment of trees left below the limit is going to return no interest unless it be due to rise in prices.

"You ask my opinion as to the difference in reproduction of softwoods on hardwood land when the softwoods are cut to 12 inches or 14 inches, as contrasted to cutting them to the lowest merchantable limit. I do not think the difference would be great, because the cutting of the trees below the 12-inch limit means very little more opening up the stand, and these trees being suppressed mainly add little to the amount of seed produced."

The defect of the diameter limit showed up very well in the tract studied. Repeated borings were made in trees throughout the hardwood type. The results, as far as any increased growth was concerned, were negative, for the reasons given above, namely, the trees left were

[2] Nehasane Park is in the Adirondack Mountains.

often old and suppressed by hardwoods, and the site conditions of the trees left were in no way changed by the removal of scattering spruce and fir from their vicinity. Only in cases of very small fir was increased growth noticed. These small trees, as mentioned before, revived and grew to size in the larger openings of the hardwood type.

As for increased growth in the spruce flat type, here, too, a disappointment was met. The crowns were quite small. Numerous borings were made in trees chosen for their thrifty appearance and favorable site conditions, but only in few instances was any sign of reviving to the new conditions noted. The trees left, though small, were over 100 years old. The borings in general, made in spruce in both types, showed no evidences of increased growth. The theory that with thinning out the stand an increased growth is obtained does not seem to apply to conditions that were met with in this study.

REPRODUCTION

In the foregoing pages it was stated that reproduction of spruce and fir was ample on spruce slopes and flats. This statement coincides with the statements and tables of Chittenden.[3]

Why fir is coming in as second growth at the expense of the spruce is not fully known. This condition has been mentioned in articles in the early numbers of the Forestry Quarterly and has been commented on in practically everything written about the spruce region. Zon, in Bulletin 55, Forest Service, on germination of balsam, says:

> "Since the seeds are scattered late in the fall, when frosts have already occurred, they lie dormant throughout the winter and come up the next spring. Hardwood leaf litter, duff, moss, mineral soil, rotten logs—all present an equally good germinating bed, if moist. Balsam differs from spruce in this respect, requiring more moisture, as may be inferred from the fact that spruce seedlings are found in drier situations, both on logs and on the ground. A rather dry and high log will have plenty of spruce seedlings and very few balsam, while a well rotted, moist log will have a great number of balsam seedlings. The same is true of stumps."

Perhaps the moisture requirements of balsam and spruce determine their relative time of germination in the fall and the spring, there being enough moisture for spruce in the fall and not enough for fir. If such is the case it would be in line with Murphy's statements in Bulletin 544, Forest Service, who noted that spruce seeds germinate in the fall

[3] Forest Conditions of Northern New Hampshire, by A. K. Chittenden. Bureau of Forestry, U. S. Dept. Agr. Bull. 55.

very soon after falling, while the balsam seeds lie over until spring, and thus find a more favorable growing period. Murphy, however, does not admit a striking difference in moisture requirements. He says:

"Balsam possesses the two distinct advantages over spruce of a plentiful supply of seed annually and of a decidedly more rapid growth, particularly in the seedling stage. While moisture, seed bed, and to a great extent the light requirements are the same for both, the more rapid growth of balsam enables it to extend its root system more vigorously and thus become established more quickly and more firmly under seed-bed conditions in which spruce, although germinating with equal facility, is later exterminated through subsequent drying out of the upper layers before its roots have become firmly established.

SUMMARY

By cutting to a diameter limit of 12 to 14 inches for softwoods in the hardwood type, the following conditions result:

1. The remaining stand of softwoods is often so small per acre as to make logging of the left-over stand expensive.
2. There is no increased growth of the remaining stand.
3. The small openings made by the removal of the scattering softwoods are taken up by second-growth fir.
4. The small openings made by the removal of the scattering softwoods are taken up by the hardwoods.
5. The forest is surely being turned into a pure hardwood growth.

In the cases where the hardwoods were taken, too, the indications are that a considerable increased amount of reproduction of softwood is coming in. The new growth is more fir than spruce, however.

By cutting to a diameter limit of 12 to 14 inches in the spruce types, the following conditions result:

1. The remaining stand blows down if on thin soil. If on fairly deep soil, some trees will stay up for a number of years, but the first case is the more common.
2. No increased growth.
3. The cost of logging greatly increased.
4. Reproduction very good, but more fir than spruce.

By clean cutting a spruce flat:

1. Reproduction is ample.
2. No loss of trees by the wind occurs.
3. Cost of logging is reduced.

The summary for clean cutting is based only on the Lincoln Pond region. I am not willing to say that every area would respond the same, but I am of the opinion that clean cutting, carefully done, will reproduce better than is commonly supposed.

EXTRA COSTS OF LOGGING NATIONAL FOREST STUMPAGE

By D. C. Birch

Forest Examiner, U. S. Forest Service

Eliminating the consideration of carrying charges, National Forest stumpage is usually worth less for immediate cutting than privately owned stumpage of the same quality and accessibility by an amount equal to the extra costs of logging due to the silvicultural cutting requirements of the Forest Service. This is true largely because the private timber-owner in the National Forest region, with few exceptions, allows his timber to be cut without any restrictions as to the method of cutting or the condition of the area after logging. The amount of this difference in value is not easy to determine exactly.

The principal factors which make up the extra expense in logging Forest Service timber are (1) increased construction cost; (2) extra care in felling, bucking, and yarding; (3) felling snags and diseased trees; (4) disposal of snags and brush, and (5) fire-protective requirements, such as cleaning up at donkey settings, providing fire-fighting equipment, etc.

EXTRA CONSTRUCTION COSTS

The extra construction cost is directly the result of a decrease in the available stand of timber to be taken out over a given set of fixed improvements, such as chutes, railroads, landings, etc. This decrease is the result of the Forest Service silvicultural requirements in leaving a portion of the merchantable stand. Logging Engineer Swift Berry conducted a study for the determination of the difference in volume and quality of timber produced from typical stands of timber in the sugar and yellow pine belt of California. The results of this study indicate that between 15 per cent and 20 per cent less timber is obtained under the Forest Service methods of marking than under the ordinary private method of logging, the difference being principally in the volume of sugar pine and yellow pine.

The cost of construction of fixed improvements in the woods spread over the entire stand usually amounts to about $1.50 per thousand feet or less in California pine operations. Assuming that 20 per cent of the merchantable stand is reserved from cutting under Forest Service regulations, the extra costs on account of construction are therefore about 37½ cents per thousand feet.

EXTRA CARE IN LOGGING

The felling requirements of the Forest Service were thought severe by some lumbermen among the early purchasers of National Forest stumpage. The chief objections were to the low stumps, to the care in protection of unmarked timber and reproduction, and the increase in cost of limbing and bucking occasioned by the more complete utilization of tops. The effect of these requirements is rather difficult to determine on account of the ever-changing standards along these lines among the lumbermen themselves. For instance, some of the more progressive outfits are cutting lower stumps now than is required by the Forest Service. In like manner they are utilizing much farther into the tops than was the practice a few years ago. The fact is that the lumber companies have improved very markedly in their utilization standards, while the Forest Service has maintained about the same position all along. One of the chief reasons why the progressive steps have been taken by the lumbermen is because it pays to do so, and will continue to pay more as the value of stumpage increases. The extra effort made to protect standing timber and groups of reproduction in the felling operation is undoubtedly an extra cost on which the lumbermen do not figure any compensating returns on account of a possible potential value of the young growth.

During the season of 1917 the writer carried out a partial study on felling operations in a typical pine-logging job which was being conducted under Forest Service timber-sale regulations. Time studies were made on 75 trees, averaging about 41 inches d. b. h. It was found that about 4 per cent of the time was spent in wedging and an additional 4 per cent of the time in planning on the direction in which to fall the tree. It is estimated that about half as much time would have been spent in wedging and planning if the work had been conducted under private cutting methods. With falling costs at $0.25 per thousand feet, it can be seen that the extra care in avoiding standing trees and groups of reproduction amounts to an insignificant quantity—about $0.01 in the above example.

The extra time consumed in yarding timber under Forest Service requirements consists in delays on account of avoiding reproduction, unmarked trees, in protecting unmarked trees that the line is fastened to, and in bringing in extra short lengths. These extra costs apply largely to steam yarding. A considerable part of California pine cut, however, is yarded with horses.

A study was conducted in the yellow and Jeffrey pine region by Logging Engineer Swift Berry during 1915 for the purpose of determining the extra costs of yarding on Government timber sales. The results of this study show that the total time involved in Government delays was approximately 3 per cent of the entire time devoted to yarding. Under Government regulations 169,480 feet board measure were yarded in 35 hours and 6 minutes, which is equivalent to the rate of 1 thousand feet in 12 minutes and 25 seconds. The loss time in terms of money amounted to about $0.06 per thousand feet board measure.

SNAG DISPOSAL

During the summer of 1917 the writer conducted a study on a timber-sale area on the Plumas National Forest for the purpose of gathering data on the cost of snag disposal. The following summary is a result of this study:

	Species					
	S. P.	Y. P.	D. F.	W. F.	I. C.	Total
Number felled	20	44	17	46	13	140
Average d. b. h.	28.80	23.70	37.88	36.00	20.77	29.0
	Average Time for Two-man Crew in Minutes					
Walking	2.89	2.65	2.51	2.06	2.34	2.44
Swamping	.42	.66	1.30	.82	.23	.72
Barking	.72	.31	2.88	2.28	.27	1.30
Undercut	3.83	2.81	5.81	5.47	2.52	4.17
Sawing	6.85	5.87	8.39	9.53	4.42	7.38
Resting	2.79	4.28	4.53	6.05	1.27	4.41
Total time	17.50	16.58	25.42	26.21	11.05	20.42

There were two men employed in the snag-disposal work. The wages paid amounted to $6.25 per day of 10 hours, or the equivalent of $0.0104 per minute. At this rate the cost of felling the average snag was $0.21. In actual practice there are not more than three snags per acre to be disposed of and usually not as many as three per acre. On the basis of the above, this would not exceed a cost of $0.63 per acre. For the sale in question the cut per acre was about 31,000 feet board measure. At this rate the cost of snag disposal per thousand feet of logged timber is about $0.02.

Several years ago a time study was conducted to determine the cost of felling snags on a Government timber sale on the Sierra National Forest. A record of the cost of felling 35 snags, with an average diameter breast high of 28 inches, was $0.24 per snag.

CUTTING DISEASED TREES

The extra cost of felling diseased trees is an item which has not been worked out very completely for District 5. In connection with the snag-disposal study on the Plumas National Forest, a time study of timber felling was conducted on 75 trees, with an average diameter breast high of 40.75 inches.

The following table has been worked up from curves based on the data collected:

Time of Felling (Exclusive of Time for Resting) in Minutes

D. b. h.	Y. P. & S. P.	D. F.	W. F.	I. C.	Numerical average
28	15.00	19.00	13.80	12.80	15.15
30	17.00	21.60	16.00	15.00	17.40
32	19.50	24.00	18.80	17.10	19.85
34	22.25	27.00	21.90	19.80	22.74
36	25.00	30.00	25.00	22.60	25.65
38	29.00	33.30	28.80	26.10	29.30
40	33.50	37.00	32.70	30.00	33.30
42	37.60	41.80	36.70	34.00	37.52
44	43.00	46.00	40.80	38.50	42.07
46	49.00	51.00	44.90	44.00	47.22
48	55.00	56.60	50.00	48.70	52.57
50	60.50	63.00	54.60	54.60	58.17
52	67.00	69.90	59.40	.....	.....
54	74.00	77.00	64.25	.....	.....

Average time resting for all species, 12.28 minutes per tree.

Without further knowledge, it is assumed that a diseased unmerchantable tree can be felled in the same time that an average merchantable tree of the same size and species can be felled, and the average diameter as found in the stand is the same as the average merchantable tree that is marked for felling.

With a maximum of three trees per acre, therefore, with an average diameter of 40 inches d. b. h. (which is very reasonable for the timber marked in timber sales in California pine), the cost of felling diseased trees is the cost of 33.30 minutes (work time) plus cost of 12.28 minutes (resting time)—a total of 45.58 minutes per tree, or a total of 136.74 minutes per acre. At $0.0104 per minute, this amounts to $1.42 per acre. The snag-disposal requirement provides that the tree be opened up sufficiently to satisfy the forest officer as to its merchantability. In actual practice this is a very slight extra cost, probably less than $0.01 per thousand feet of the timber cut, and very often the work is applied to merchantable material that is obtained from the diseased tree.

With a stand of 20,000 feet per acre (which is conservative for the average timber-sale area in California pine) the cost is 7 cents per thousand feet.

BRUSH DISPOSAL

It is the general practice to require operators in District 5 timber sales to pile and burn all brush resulting from the felled timber and snags. The work of piling is often subcontracted at rates ranging from 17 cents to 25 cents per thousand feet of timber cut. Records of brush-piling work done directly under the supervision of the company show that the cost ranges from 11 cents to 26 cents per thousand feet of timber cut. Brush burning is usually done by the operator at a cost of from 2 cents to 5 cents per thousand feet of the timber cut, with an average of possibly 4 cents per thousand. There has recently been a sharp advance in labor costs. A fair present average, therefore, for piling and burning is 30 cents per thousand feet.

FIRE-PROTECTIVE MEASURES

Ordinarily one man can do all of the extra cleaning up around a donkey setting within one day at a cost of about $3. This will ordinarily amount to less than $0.01 per thousand feet. The investment in spark-arrester and fire-fighting equipment should not exceed $75 for each machine and should remain in use for several years. A depreciation figure at $0.01 per thousand feet should retire the investment easily.

SUMMARY

The following items may be considered average extra costs of logging on account of Government timber-sale regulations:

	Cost per thousand, log scale
Construction cost	$0.375
Felling and bucking	0.01
Yarding	0.06
Snag disposal	0.02
Diseased trees	0.07
Brush disposal	0.30
Fire-protective measures	0.02
	$0.855

Items Offsetting Extra Costs

According to the results of Mr. Berry's report, referred to above, the average quality of timber taken out under Forest Service methods is considerably better than that taken out under private cutting methods.

other things being equal. The difference in quality is chiefly in the pine timber, and the explanation lies simply in the fact that the reservation from cutting by the Forest Service of the smaller and younger trees of the stand results in a larger average sawlog. The amount of increase in quality expressed in money amounts to from 50 cents to $1, or an average of 75 cents per thousand feet when based on current grade selling prices.

Time studies of felling operations indicate that the unit volume cost of felling small timber is much greater than for larger timber. The data collected by the writer during 1917 shows that the unit cost of felling a tree 30 inches d. b. h. is 25 per cent greater than the cost of felling a tree of the same species 40 inches d. b. h. The small increased cost of felling on account of avoiding other timber is easily offset by the saving in applying the falling to a larger average tree.

It is a serious question whether the whole expenditure on extra fire precaution is not more than offset by the reduction in fire-fighting expense. Some of the progressive lumbermen are taking the view that the preventative measures required by the Forest Service are well worth while from the saving of fire-suppression expenditures that are a result of unpreparedness.

Summing up the items offsetting the extra cost of logging:

Increased quality	.75
Felling and bucking	.01
Fire-protective measures	.02
Total	$0.78

Net Results

Summary of extra costs	$0.855
Summary of items offsetting extra costs	0.78
Extra costs net	$0.075

FURROW PLANTING UPON THE SAND PLAINS OF MICHIGAN

By Huber C. Hilton

Forest Supervisor, Michigan National Forest

The planting of trees in furrows is now uniformly practiced in reforestation work upon the jack-pine plains of Michigan, both by the State and Federal governments. This method has developed in an effort to find a more economical method than any of the old-style practices, as well as to determine a method which will also give more satisfactory results on this particular class of site. The planting of nursery stock in furrows developed gradually, after the usual or former common methods had proven unsatisfactory because of the small survival secured or the excessive cost. The usual plains region supports an excessive amount of ground cover or vegetation which forms a complete density in many cases. This ground cover commonly includes grasses, weeds, huckleberry, wintergreen, cinquefoil, kinnikinic, ceanothus, and sweet fern—plants which form a low, and usually a quite dense, cover. The methods of planting by the use of spade, mattock, or special planting tool without an additional preparation of the soil proved costly and inadvisable, because of the length of time required for the trees to become established and to overcome the competition of surrounding vegetation. The use of mattocks, which is a common method in eastern United States and in the mountain sections, proved inadvisable for the same reasons. Also the preparation of holes and later the actual planting often comprised two different operations and required two men to complete it—one to make the hole and one to set the tree. In planting in furrows one man completes the operation. The use of planting tools alone has also been tried, but is unsatisfactory, both because of the competition of the surrounding vegetation is not reduced and because it is difficult to keep track of the planting rows where small stock is used. The furrowed planting area serves as an additional protective measure, since the furrows retard the rapid spread of a ground fire for several years after the planting.

PLANTING OR FURROWING

A sulky plow has proven superior to the walking style, in that a better or cleaner furrow is secured and the cost of furrowing reduced by its use. The sulky plow can be easily raised or lowered, turned quickly at the points where a complete turn is to be made, easily raised or lowered, and can be hauled through brush or over down timber more easily than can a walking plow. A plow with either a two or three horse base has proven a very satisfactory implement for this work. The furrows are usually plowed from 12 to 14 inches wide and just deep enough to remove the sod or heavy growth of vegetation. The distance between furrows is from 6 to 8 feet, depending upon the number of trees per acre to be planted. The furrows can be plowed at any time when work is slack or when teams can be easily secured.

PLANTING TOOLS

A special tool has been developed as a result of repeated experiments and has proved very satisfactory for this class of work. These tools are locally designated planting tools or bars, the lower part of which consists of a wedge-shaped piece of steel from 8 to 12 inches long, 3 to 4 inches wide, and about three-eighths of an inch thick at the top of the wedge. The steel tapers down to a thin rounded point at the lower end. The handle consists of a piece of galvanized iron "cold shrunk" upon a short extension of the wedge and makes the length of the tool slightly longer than a short-handled shovel. A grip handle similar to the handles upon the common potato forks is often attached and is considered a particularly desirable feature in ease of handling and in allowing a heavy downward thrust to be made without undue effort. The State planters prefer a smaller and lighter tool of about the minimum dimensions quoted, without the grip handle, but having a step attachment of a small iron extension from the wedge and used in forcing the bar into the soil with the foot. The men who have worked in Federal planting operations prefer the heavier tools, since it is possible to force the bar to the proper depth by one downward motion.

The planting stock is carried in pails, wooden boxes, or specially made galvanized iron boxes. The pails are not as handy in removing stock, nor can as many trees be carried as in boxes. The galvanized iron boxes are lighter than the wooden, but the latter are practically secured without cost and prove very satisfactory. The boxes are preferably from 10 to 12 inches wide, 20 to 24 inches long, and from 5 to 7 inches deep for the usual run of 2–0 or 2–1 stock. A stiff strap 1 to 1½ inches wide is attached from end to end of the wooden box and forms a handle which constantly remains upright and away from the trees. This handle can be easily grasped as the planter proceeds from one planting spot to the next. Very little moss or other cover is needed to protect the trees in these boxes under ordinary weather conditions.

PLANTING STOCK

The species most commonly planted is Norway or red pine (*Pinus resinosa*, Ait.). White pine (*Pinus strobus*, Linn.) and Scotch pine (*Pinus sylvestris*, Linn.) are also frequently planted. The exotics, including Austrian pine, western yellow pine, lodgepole pine, Douglas fir, and European larch have proved of doubtful, if of any, value. Scotch pine is not considered equal to Norway pine for planting purposes, since the tree grows quite bushy on the more sterile soil and is often crooked. It is also unlikely that the timber produced will be as valuable as the tall, clean-boled Norway pine, which grows even upon the most sterile parts of the jack-pine plains. White pine, if planted upon the more open plains, grows very slowly and is often quite bushy. The white pine commonly found on the plains is very limby, with a large number of heavy limbs, and it is unlikely that rapid growth will result, nor will valuable lumber be produced by this species.

The planting of jack pine has been practiced to some extent by the State and is used as a filler with Scotch, Norway, or white pine to force these trees to clean at an early period. In this case the trees are commonly spaced 5 by 5 or 6 by 6 feet apart.

The planting work has shown, as a result of repeated plantations, that the use of transplant stock is unwarranted, considering the additional cost of production, since excellent results are secured from seedling stock. The stock most commonly used is 2–0 seedlings, although some very successful plantations have been established with 1–0 stock both by the State and Federal governments. The work of planting 1–0 stock is made somewhat difficult by its small size, since the most convenient and the size which can be planted most rapidly is a good 2–0 seedling or 2–1 transplant rather than a small 1–0 seedling or a large transplant.

PLANTING

The planting crew is organized under a foreman, who may or may not do some actual planting, depending upon the arrangement made for keeping the crews supplied with trees. It is usually possible to drive over the planting area with wagon and team and several crews of from 6 to 10 planters kept supplied with trees. The foreman in charge usually leads the crew and establishes the pace. Each man plants in and completes the furrow for its entire length, and it is therefore desirable to have long rows (one-quarter mile is not too long) in order that as little time as possible may be lost in turning about or in resting at the end of the rows. Each planter carries a planting tool and box of trees. The planter drops his box alongside the furrow, takes up a tree and makes a hole with a downward thrust of the bar, which is opened up to the desired width with a forward and backward movement of the handle. The tree is then slipped or lowered into the hole along the blade of the planting bar, the bar removed, and the tree slightly moved above to straighten out the roots if they have been disturbed by the removal of the bar. The soil is then forced back against the tree as it is held at the proper elevation in the hole by inserting the bar into the soil from 2 to 3 inches ahead of the tree. The hole last made is covered to avoid the drying out of the soil by stepping upon it, as the planter paces ahead to the next tree distance. The only possible disadvantage in this method is that all the roots are crowded into one plane. This is also the case in transplanting when the trencher is used and no injury results—in either case possibly because the roots are small and are not spread very widely.

COSTS

The cost of plowing the furrows depends upon the soil conditions, whether moist or dry, and the amount and character of ground cover, but usually runs from 50 to 60 cents an acre where furrows are made from 6 to 8 feet apart and team and man hired at $5 a day. The actual planting of the trees when average 2-0 or 2–1 stock is used runs from $2 to $2.40 an acre, depending on the number of hours worked. The State men work 10 hours a day and the Government men but 8 hours for the same rate and pay. Planting at a certain cost per thousand under some form of a contract system is suggested as a better means of handling the wage item. This, of course, will require the careful supervision of an attending Forest officer. The planters are able to average from 1,700 to 2,000 trees a day for 8 hours and slightly better than this for 10 hours.

ADVANTAGES OF THE METHOD OVER OTHERS ATTEMPTED

1. The cost of the work is less.
2. The percentage of survival is high.
3. The trees make a more rapid and satisfactory growth.
4. The trees are not forced to compete with any surrounding vegetation for 3 or 4 years after planting.

5. The trees planted at a lower level than surrounding soil cover are better able to withstand a period of drought.

6. The furrows can be plowed at any slack time and remain unplanted for two years, since little growth of vegetation enters the furrow and no erosion occurs in this flat region. The plantations have shown no advantage either with fall or spring planting, except that some heaving of late fall-planted small 1–0 stock sometimes results.

7. The addition of furrows over the plantations serves as additional fire guard for ground fires for several years.

RESULTS

Reforestation in planting by the use of planting bars in furrows has proved very satisfactory under ordinary weather conditions. An exceedingly dry summer season may occasion a heavy loss, but this is never due to the fault of the method, since the loss has proved greater under these conditions when other methods have been followed. The Federal policy of spacing 8 by 8 feet is believed worthy of continuation, since the small amount of loss does not necessitate replanting, and the Norway pine will be sufficiently close together to clean well, as determined by the appearance of young, middle-aged, and mature timber now found upon the plains regions. A survival of from 87 to 96 per cent, using 2–0 stock, is usually the average figure obtained in furrows. The several Norway plantations for the Michigan National Forest average 92.6 per cent after 3 years. A loss of but from 1 to 3 per cent is not uncommon during the first year if good stock is used in the planting operations, even though some dry periods of from 3 to 5 weeks may occur and in which the soil appears entirely dry to the touch. Norway pine exhibits a remarkable ability to live through drought, as has been repeatedly shown where the soil appears dry even to a depth of 4 feet. This is explained by the soil, which is of sand and in which practically all the moisture present is available to the plant. The tree can withstand drought in this soil under these conditions, but would quickly die in a loam or clay soil.

MEASUREMENT OF FUEL WOOD

By H. O. Cook

Assistant Forester, Massachusetts Forestry Department

Foresters and wood dealers are familiar with the failings of the stacked cord as a unit of measure for fuel wood. It is a valueless unit for a majority of the ultimate consumers in Massachusetts, because they purchase their wood not in 4-foot lengths, but in shorter lengths, fitted for the stove or fireplace. While in many places wood was for the consumer a luxury, to be used in small quantities, occasionally he was able to get along without a satisfactory method of measurement; but with the coal shortage wood suddenly became a vital necessity, not only to householders, but to hotels, office buildings, and factories, and the consumer has become vitally interested in a method of measurement under which he can tell how much wood he is purchasing. There is a growing number of woodlot operators who no longer cut their wood into 4-foot sticks and pile it, but cut the trees into miscellaneous long lengths, sometimes called shed lengths, and haul direct to a cordwood saw, where it is cut into stove and fireplace lengths. In such operations the stacked cord has no value as a unit of measure. The Massachusetts State Forester has carried on a series of experiments to determine the average number of cubic feet in a cord of wood cut into 2-foot (one cut), 16-inch (two cuts), and 12-inch (three cuts) lengths and thrown into a bin or wagon body.

The experiments were carried on at two places—one in Dover and the other at Marion. The trees in these operations were utilized full length, but for the purpose of the experiment a few cords were cut into regulation form foot-lengths and stacked into half-cord piles. These piles were then taken to the saw and cut into 2-foot, 16-inch, and 1-foot lengths, and put into a bin the dimensions of which were 5 by 5 by 4 feet. Care was taken to level the top of the pile in the bin, its height measured, and the cubic contents of the half cord thus computed. We soon found that the 2-foot wood piled so irregularly that it would not be possible to establish a standard relation for it, and the experiment was confined to 16-inch and 12-inch wood. Three classes of wood were distinguished—all cleft, all round, and mixed round and cleft. Naturally, in creating a standard, the average cubic contents of the mixed round and cleft wood should be the one chosen. When cordwood is cut into short lengths and thrown into a box, one expects its cubic contents to swell, but the experiment yielded some unexpected results. Large-size all-cleft wood swells more than small round wood—16-inch wood swells more than the 12-inch. The reason is that the smaller the pieces into which the wood is cut the more closely it packs when thrown into the bin. The mixed round and cleft wood gave very uniform results, the average of 15 cords in the case of 12-inch wood being 145 cubic feet and in the case of 16-inch 160 cubic feet. The amount of actual solid wood to be obtained by this method of measurement is bound to be much more uniform than that obtained in the stacked cord, so that any deviation from these averages is more due to the irregularity of the solid contents of the stacked cord than to the hazards of loose piling in a bin. In order to determine whether the size of bin made any difference to the cubic contents, one was constructed which was 8 feet on a side instead of 5. In the case of 12-inch wood this gave results identical with the 5-foot bin. In the case of 16-inch, the contents are a little smaller, but not enough to be a serious matter. A bin which was only 2½ feet wide instead of 5 feet was then constructed, and the cubic contents of a cord became 184 cubic feet instead of 145 feet, the average. It is apparent, then, that for the measurement of thrown wood the bin must not be less than 4 or 5 feet in its least dimension. It can be larger, but as a practical matter a bin of large surface dimensions is not recommended, because a slight error in measuring the height of the wood means a considerable error in the cubic contents thereof. It appears that a man who sells considerable quantities of short wood should be required to provide himself with a bin 5 feet wide, 8 feet long, and 4 feet deep. This bin, level full, with 16-inch wood, will contain 1 cord. If filled to a depth of 3 feet 8 inches with 12-inch wood, it will contain 1 cord. A removable partition placed across the middle will make it possible to measure half cords. With an arrangement of this kind it will be possible for the dealer to keep on hand a large stock of short wood, and not be obliged to go to a pile of 4-foot wood and measure out each individual order and then saw it up, as is the custom at present.

Average Number of Cubic Feet per Cord of Fuel Wood Cut into 12 and 16 Inch Lengths and Thrown into Bin 5 by 5 by 4

No. of cords	Class of wood	Length *Inches*	Species	Average *Cubic feet*
6	All round	12	Oak	140
5	All cleft	12	Oak	155
15	Round and cleft	12	Oak	145
4	Round	12	Gray birch	138
5	Round	16	Oak	155
7	Round and cleft	16	Oak	160

PLAN FOR PERMANENT SAMPLE PLOTS IN THE ADIRONDACKS[1]

There is need for a systematic study of cut-over areas in the Adirondacks. It is impossible to predict to any degree of accuracy the net increment of the trees left after cutting, the height and diameter growth of individual trees, the death rate of some of the older trees, nor is it possible to foretell the actual effect on reproduction and on the remaining stand of the different methods of cutting. The most pressing need of today is to ascertain actual increment under different methods of cutting and actual results in reproduction. These plots are designed to ascertain what happens, leaving to later, more intensive plots the study of why it happens.[2]

OBJECT OF SAMPLE PLOTS

The general object of these permanent sample plots is to secure accurate data under different methods of cutting along the following lines as a foundation for a system of management:

1. Actual increment in feet board measure or cubic feet per unit of area.
2. Height and diameter growth of individual trees.
3. Death rate in different age classes or diameter classes.
4. Changes and development in young growth.
5. Accurate photographic record to supplement paragraph 4.

LOCATION AND AREA

Areas should be selected in accordance with the attached memorandum. It is desirable that plots one acre in size be established where one general density, exposure, type, or aspect would be included; otherwise areas of one-half or one-quarter acre should be selected which embody a single feature. No plot of over one acre or under one-quarter acre should be established. They should be rectangular in shape. The square is a convenient form.

ESTABLISHMENT

The co-operation of land-owners and their contractors should be enlisted in order that the plots may not be molested.

[1] Adopted by the Sample Plot Committee of the New York Section, Society of American Foresters, at the meeting at Utica, N. Y., March 14, 1918.

[2] The need of such intensively studied plots is also great, and it is to be hoped that a few of these will be established as soon as possible.

Corners and Boundaries.—All corners[3] should be either of very durable wood or of some semi-durable species which has been seasoned for some time or creosoted.

PLAN FOR PERMANENT SAMPLE PLOTS

In marking corners the letter "S" should be scribed thereon, so as to indicate a silvicultural area. Corners should be witnessed where practicable and tied to some known point by a traverse. Each co-operator should number his plots serially. The marking of S-2 indicates corner of sample plot number 2.

All plot corners should be substantial, and set 2 feet in the ground where possible and 3 feet above the surface; the smaller stakes should be driven in until firm. The corner posts should be painted if practicable.

Measurements

Diameter.—All merchantable species having an average diameter at breast height, outside the bark, of an even 4.0 inches or over should be measured and numbered. Stumps from cuttings within a definitely known year may be measured, recorded, and located if desired.

All diameter measurements should be recorded to the nearest tenth of an inch, the measurement being taken 4.5 feet from the ground; this point to be secured by measurement, using an average for trees on sloping ground. Where a measurement cannot be taken at breast height, it should be taken at the nearest practical point above and below breast height and an average obtained; where a fork occurs below breast height, each fork should be numbered and recorded separately; where the fork is too high for this, the main stem of the tree should be measured below and where the swelling (from the fork) is not appreciable. Care must be taken that swellings or small limbs are not included in the measured diameter. Notes should be made of any irregularities in the form of the tree which visibly affect the figures obtained, such as large burns, deep scars, swellings, etc. A self-winding diameter tape is advised.[4] If calipers are used, they should always be held at right angles to the bole of the tree and readings should be made in two directions. The first diameter reading should be taken directly at the center of the painted cross, so that the tree's diameter (at that point) divided by two will appear directly at the cross—that is, for a reading of 20

[3] Where the danger from fire is great the plot corners should be surrounded by large mounds of earth or rock or both.

[4] Lufkin Rule Co., Saginaw, Mich.

inches the 10-inch mark on the calipers should appear at the cross. The second reading should be at right angles thereto. Both readings should be recorded.

Height.—All trees having a diameter breast high of 4 inches or over outside the bark should have their height recorded with an accurate hypsometer; the distance from the tree to the instrument should in all cases be measured with a steel tape. In measuring leaning trees the hypsometer should be set for a horizontal distance measured from a point directly under the top of the tree.

Marking and Numbering the Trees

The trees shall be marked by means of a distinct painted cross, the intersection of which is at the measured breast height (4.5 feet above ground). Crosses should be placed on the same side of every tree on a sample plot.

The trees shall be numbered with paint in a legible manner consecutively, with Arabic numerals placed in the upper right-hand quadrant of the cross. The use of a stencil is suggested.

On rough-barked trees the use of a draw-knife to remove the outer bark where it is to be painted is recommended.

Individual Tree Records

A suitable field notebook should be used in keeping the records of the measurements of the trees on the plots. Each sheet should be marked with the name of the co-operator, the sample-plot number, the location, the date, and the serial page number. In accordance with the standard forms furnished, the following data are to be recorded:

1. Consecutive tree number.
2. Species.
3. D. b. h. (two measurements if calipered).
4. Clear length in feet to base of crown in case of hardwoods.
5. Total height of tree in feet.
6. Volume in feet board measure or cubic feet.[5] (Use designated volume tables. Conservation Commission will furnish these.)
7. Damage to the tree or crown by insect, fires, etc., if expedient.
8. Crown class, if practicable.

Record species by common names preferably.

If calipers are used, the diameter taken first, whether on the south, north, east, or west side of the tree, should be just at the center of the

[5] Computed in the Office.

cross, as described above; the second measurement, taken at right angles to this, should be entered above it in the record.

In many instances the first live limb on a tree is not indicative of the height of the base of the crown from the ground; in such instances the base of the crown should be taken and not the limb. This measurement should be taken with the hypsometer, except where the limb is very close to the ground.

Seedling Count Strips.—Strips five feet (or 8 links) in width should be laid out with white cord across the major dimension of each permanent sample plot, and all the young trees of commercial species (below 4 inches d. b. h.) counted and recorded in height classes and according to condition as provided on the standardized form. Such a strip should include from 1 to 5 per cent of the total area (1/100 to 1/20 of an acre). These seedling count strips should be tied to some permanent stake and so described.

Personnel

The crew may consist of three men, of whom one at least has technical training. The work on the plots should be divided and done in the following order:

1. *Surveying.*—Placing the large corner-posts.
2. *Measurements of Individual Trees.*—One man should paint the crosses and numbers on the trees and do the diameter taping or calipering, the second man taking the height, and the man in charge writing the data as they are given to him and such information as is required.
3. *Seedling Count. Strips.*—Small stakes are to be set and the strip located with reference to a corner-post or posts.
4. *The Reports.*—The reports and additional notes in accordance with standardized form should be made after all the other work on the plots (including the photographing) has been done in the field. The preparation of the final report may be done in the office.

Photographs

In making a photographic study of the plots at the time of measurement it must be understood that these photographs aim to show at least three things: (1) A general view of the plot to show the character of the forest; (2) a series of photographs to show height growth and filling in of crown cover of a representative detailed portion of the plot, and (3) a series to show the progressive changes on the seedling strip. In order to get this from the exact point, each time the camera might be centered over a permanent marked object and oriented.

Outline for Permanent Sample-plot Report

(Use standardized form for description of sample plot in the field.)

1. *Date established and by whom.*
   Ownership of land.
2. *Location.*
   Township, lot, etc. Field-notes of boundaries. Field-notes of the traverse to nearest known point.
3. *Safeguarding from molestation.*
   Copy of letter to owner or his contractors, enlisting their co-operation.
4. *Protection from fire and record of damage.*
   Record of any accidental fires or other damage that may occur after plot is established, with date and intensity (in case of fire) or record of cutting or windfall.
5. *Area.*
   Acres. Dimensions.
6. *Elevations.*
   Relative and above sea-level.
7. *Topography.*
8. *Soil and rock outcrop, if any.*
9. *Exposure.*
   Protection from winds, character of surrounding lands—private, State, cut-over, or virgin, etc.
10. *The forest.*
    a. Original stand, composition, relative importance of species.
    b. Cutting, date and character, brush disposal, etc.
    c. Remaining stand, composition, density, occurrence.
    Reproduction, density, occurrence, size, age, rate of growth, health.
    d. Underbrush.
    e. Ground cover.
11. *Damage (prior to establishment of plot).*
    a. Fire.
    b. Grazing by stock or game.
    c. Fungi.
    d. Insects.
    e. Miscellaneous.
12. *Method of work.*
    a. Date of instructions, followed with modifications noted.
    b. Personnel of party, with names.
    c. Instruments used.
    d. Volume tables and log rules used.
13. *List of photographs.*
14. *Cost.*
    Include salaries, subsidence for days actually worked on plot. Include stakes and other material.
15. *Record of trees.*
    a. Total number, with inclusive numbers.
    b. Lists of trees and shrubs.

Outline for Report on Seedling Count Strip

(Use standardized form for field-notes.)

1. Strip area and location in plot.
2. Slope and exposure.
3. Record sheet.

Office Work

At least three typewritten copies (on thin white paper) should be made.

1. Original and one carbon to superintendent of State forests for his files.
2. One extra copy for office files of co-operator.
3. Extra copies as desired.
4. Sketch map of location of plots and of traverse to nearest known point.
5. Location on U. S. Geological Survey sheet.

Miscellaneous

Thin white paper 8½ by 11 inches should be used; the last dimension should be parallel with the platen of the typewriter.

All original notes, maps, and records should be placed in the files of the owner on whose land the plots are established.

All records should be twice checked for errors.

Committee on Permanent Sample Plots:

S. N. SPRING, *Chairman.*
F. A. GAYLORD.
A. S. HOPKINS.
F. F. MOON.
A. B. RECKNAGEL.

REVIEWS

Tests of the Absorption and Penetration of Coal Tar and Creosote in Longleaf Pine. Bull. No. 607, U. S. Dept. of Agri., June 7, 1918. By Clyde H. Teesdale and J. D. McLean.

This bulletin describes a series of tests to determine the effect of the addition of coal tar to creosote upon the ease of injection of the preservative into longleaf pine, especially in the treatment of paving blocks. Two methods were employed to secure this information, through the use of the "penetrance apparatus" devised by members of the staff of the Madison Laboratory of the U. S. Forest Service, and by treating paving blocks of the usual size in an experimental retort. Six commercial coal-tar creosotes from different sources and five coal tars from by-product ovens and gas-house plants were used in the tests. Carbon-free tar was obtained by the chloroform solution method, which has been subjected to some discussion. A pressure of 75 pounds per square inch was used in the penetrance apparatus, this pressure being maintained for two hours at a temperature of 160°. The blocks were treated in the experimental retort under varying conditions until a uniform penetration or absorption of 16 pounds per cubic foot was obtained in each instance. Various mixtures of creosote, carbon-free tar, and unfiltered tar were used, and from the results of the treatment the following conclusions are drawn:

The addition of coal tar to the creosote increased the difficulty of injection, which became proportionately more difficult as tars containing free carbon in increasing amounts were used in the mixtures. Tars containing small free-carbon particles increased the difficulty of injection more than tars containing larger free-carbon particles. The viscosity of mixtures of coal tar and creosote does not appear to be an index of the ease of injection of such mixtures into longleaf pine. The most important factors influencing penetration appear to be—

1. The character and composition of the bitumens.
2. The amount of free carbon in the tar.
3. The condition and size of the free-carbon particles.

It was found that by increasing the temperature of the preservative the ease of injection of the preservative was materially increased. The reviewer wishes to call attention to the fact that this apparent discrepancy between commercial practice and these tests is very probably due to the use of wood containing an average moisture content varying from 2 to 11 per cent. Such thorough seasoning cannot ordinarily be obtained in commercial practice, especially when "artificial" seasoning methods are employed.

B. L. G.

Report of the Forest Branch of the Department of Lands, Province of British Columbia, for the Year Ending December 31, 1917. Victoria, B. C. 1918. Pp. 26.

This report from first to last consists of tables and diagrams. It starts out, without prefatory remarks, with a set of tables and diagrams showing the returns of the timber industry in British Columbia. Minor materials being translated into board measure, the cut for 1917 comes out precisely to the same figure as that for 1916, namely, 1,161,750,000, but the value is nearly 40 per cent larger, with $48,300,469. Of this around $44,000,000 is exported, Australia and the United Kingdom taking the bulk, with about 90 per cent. A diagram, placing the exports from Pacific ports for the last five years in comparison, shows in general a decline of exports, but for British Columbia an increase to Australia, China, and Africa. Diagrams, giving output by districts and species, show Vancouver as to district and Douglas fir as to species to far outdistance all others, only cedar coming into closer competition.

Timber sales were made at the remarkably low average price of 99 cents per thousand board feet, Douglas fir bringing $1.12. The total revenue collected from the forest amounted to $2,338,333, or 16 per cent over the preceding year and bringing it back to the amount collected in 1914, but remaining considerably behind 1913, when it amounted to nearly $3,000,000.

The expenditures were round $229,000, besides $140,000 contribution to the forest protection fund, a similar amount being contributed by the licensees. A statement dating back to 1912 shows expenditures for fire protection in some years running over $400,000, and for nine months in 1917 to over $200,000. There are now 13,963 licensees almost half of them in arrears. A relief act passed in 1917 allows such lapse for only one year of grace, and it is expected that soon the number of dead licenses will be known, which hitherto was impossible, as many had to be considered reinstatable. Crown-grant or private timber lands amount to almost one million acres, valued or assessed at $9.61 per acre, the best district running up to $18.31.

From tables exhibiting the condition of the Forest Branch organization we learn that the personnel is reduced from 378 in 1915 to 287. This reduction appears mainly to have hit the technical staff and rangers, the staff having been reduced by 50 per cent, the rangers by 60 per cent. An increase of patrolmen from 25 to 92 appears to be an attempt to supplant the rangers. There are 150,000,000 acres involved; they are divided into 29 ranger districts, hence averaging over 4 million to the district, but running from 2 million to over 11 million acres. The average minimum of assistant rangers' and patrolmen's districts runs close to one million acres.

The usual fire statistics appear in detail, and the improvements in roads, trails, telephone lines, etc., on which the modest sum of a little over $6,000 was spent.

B. E. F.

Report of the Division of Forestry, Department of Conservation, of Louisiana, 1916-18. Reprint from the Biennial Report of the Department.

Forest and Grass Fires in Louisiana. By R. D. Forbes, Superintendent of Forestry. Bull. 6, Dept. of Conservation.

As far as can be found out from indications in the report of the "Superintendent" of Forestry, the first legislation in the interest of forestry in Louisiana dates back to 1904, for the inauguration of a "department" of forestry and of a "State forester," "under general supervision of the conservation commission," was enacted in 1910 as an amendment of the 1904 act. The nomenclature of the officials is certainly confused.

According to the law of 1916, there is provision made for a "forestry department" of the "department of conservation," which latter is presided over by a single commissioner, who is to consult, however, with an unpaid "general forestry advisory board" of four appointed members, with the commissioner as chairman. "Said membership shall be chosen, two from well-known timber owners, one from farmland owners interested in farmland reforesation, and the professor of forestry in the State University. The said forestry advisory board shall meet quarterly at the domicile of the department of conservation, and not oftener, except on call of the chairman, and shall have no salary, compensation, or per diem, but shall have actual traveling expenses for attendance upon such meetings." A "technically trained forester" is to "superintend" the forestry "department." The law also provides funds in the shape of one-fifth of the tax on timber cut and turpentine gathered, called "severance" license, which runs, according to kind, from 2 to 4 cents per thousand and 1 cent per barrel, estimated to amount to $20,000.

This is indeed, after 14 years of effort, still a very small beginning, when it is considered that Louisiana, with around a 4-billion-feet cut, being second in furnishing over 10 per cent of the total lumber cut of the country, and with a stand of 92 billion feet, will shortly have exhausted its magnificent timber resource, and should bend every effort to perpetuating it on the lands which are fit for nothing else, estimated at 20 per cent or more of the land area.

The most interesting part of the report refers to the operation of a law (1910) which permits a forest owner of land assessed at less than $5 to place the same for reforestation purposes under the department at the reduced valuation of $1 per acre. Under this law the Urania Lumber Company, in 1913, placed 30,000 acres of cut-over and second-growth lands under the department, which serve as an excellent experiment and demonstration forest. Systematic experiments seem to have already demonstrated that, given a sufficient number of seed trees, protection against hogs and fire will furnish an abundant regeneration of the longleaf pine, and fire protection alone assure the regeneration of loblolly and shortleaf pines. About 2,500 acres were five years ago surrounded by a hog-proof fence. Cattle were, however, allowed to graze, and it is judged may for ten years be admitted before the grass is shaded out. The cut had been made to an 8-inch limit. On quarter-acre experimental plots in the fenced, unburned plot in three years longleaf pine seedlings increased by 90 per cent; in the fenced, but burned, plot by 80 per cent; in the unfenced and unburned plots the longleaf-pine seedlings were almost wiped out, but loblolly and shortleaf still increased slightly in number.

A wrong deduction is made on page 12 of the report as regards frequency of seed years in longleaf pine judged from this increase, which may be due to the occurrence of a seed year within the three years without vitiating the hitherto accepted usual periodicity of six or seven years. Also the height growth of the seedlings on the burned plots is already noticeably less than on the unburned plots and the general vigor is less.

Reference is made to two studies by Yale students regarding expense of logging small logs and the rate of growth of small trees left after logging. It was found that trees smaller than 9 or 10 inches on the stump and producing no larger than a 7-inch log are utilized at a loss by the average mill, and that such small trees left after logging, which were found to be mostly culls and runts of the virgin stand, and probably as old as the logged trees, averaging 8 inches d. b. h. in 1900, had by 1917 grown to 12 inches average. The volume per acre, there being about 8 trees left on the average, had grown from 226 board feet to 803 board feet, or 15 per cent!—convincing proof that conservative logging pays, at least in the southern pines.

The Urania Lumber Company is benefiting from this knowledge by cutting to 8 inch, and is logging with a steam skidder with a system of skidding lanes, as described by the reviewer at least 20 years ago. Another, the Great Southern Lumber Company, is also co-operating with the department in fire protection, employing a technical forester, and proposes systematic regeneration and reforestation.

Considerable space is given to the discussions of the cut-over land conference held at New Orleans in April, 1917. The very rational proposition is made that land classification is the first basis for inaugurating a land-settlement policy; it is pointed out that stock-ranching is not a poor man's game, but requires capital, since the piny woods range is not a year-round range.

In the report, as well as in the bulletin, the usual arguments and data regarding damage from forest fires are brought forward, each interest involved being separately discussed, particular stress being laid on the fact that even the light burning practiced so generally in the South is detrimental to the range, killing out the better forage plants, and even to timber, by gradually eating into and weakening trunks and causing windfall. In a particular case a damage of $3.50 per acre from this latter cause was figured.

The fire loss in 1917, which is admitted to have been the worst in twenty years, is estimated at over $1,400,000—equal to 2½ mills on every dollar's worth of property in the State, or 4 mills on all property outside of the urban parish of Orleans. This includes over one million dollars' worth of mature timber.

There appears to be no organized effort made to stop or diminish this fire loss, except some feeble legislation imposing fines and imprisonment for setting fires, or allowing them to escape, and obligation imposed on railways to keep rights of way clear and to abstain from dumping coals. In the absence of machinery to apply the law, it is probably rarely enforced. This, in a State where still at least 25 per cent of the fires are of incendiary origin, is a sad commentary.

The superintendent seems to rely at present mainly on educational propaganda, but proposes to district the more endangered territory into patrol districts of 400 to 500 thousand acres, which also has more educational value than it promises adequate control.

While Louisiana is on the right road in forestry, it is only at the start of it.

B. E. F.

Forest Fires in Canada, 1914-16. By T. W. Dwight. Bull. 64, Dominion Forestry Branch, Department of Interior. Ottawa, Canada. 1918. Pp. 45.

This bulletin gives summarized description of main forest regions (by provinces), as to precipitation, settlement, facilities of travel for patrolmen, control over railways, character of forests, and character of fire-patrol administration.

Under "Influence of Weather Conditions," the relationship between temperature and precipitation, on the one hand, with the occurrence and spread of fires, on the other, is discussed. Co-operative weather forecasting in relation to fire prevention and control comes in for discussion.

The discussion of causes of fires shows that the permit system of regulating settlers' clearing fires has been remarkably effective in reducing losses, wherever enforced. The adoption of this system has spread rapidly in the various provinces. The fire-protective regulations of the Dominion Railway Commission have also been notably effective in reducing damage from railway fires on lines under its jurisdiction. The Canadian Government railways are not so subject, though a change in this respect is now forecast by the Government. Lightning is the one non-preventable cause of forest fires. Over 90 per cent of the fires are due to some form of human carelessness. Campers, settlers, and railways are still the chief agencies responsible for forest fires. A significant point is the large number of fires of which the cause is still reported as unknown; this, of course, is an indication of incomplete organization and inadequate staff, intensified by war conditions. The statistics of fire losses quoted are much more complete as to British Columbia and the prairie provinces than as to the provinces of eastern Canada.

Tables show for the western provinces and for Ontario the patrol staffs maintained, areas patrolled, and permanent improvements constructed. As might be expected, the most intensive patrol in the western provinces is on Dominion parks, where the average patrol district comprises from 80,000 to 90,000 acres. In British Columbia the average district on provincial lands has increased from 400,000 acres in 1914 to 806,000 acres in 1916—due to shortage of funds and depletion of staff on account of war conditions. In the same province on Dominion forest reserves in the railway belt the average patrol district was 194,-000 acres in 1914 and 175,000 acres in 1915 and 1916—an increase in intensiveness, notwithstanding the war. On Dominion forest reserves in Alberta, Saskatchewan, and Manitoba the average patrol district decreases from 285,000 acres in 1914 to 199,000 acres in 1916. On Dominion Crown lands outside the forest reserves in these three provinces the corresponding figures are 1,200,000 acres and 1,047,000 acres respectively, showing a much more intensive patrol on the forest reserves than on the vast areas of unorganized more or less forested lands outside, including a very considerable area withdrawn for proposed new reserves, pending action by Parliament.

The average actual cost of patrol per acre, exclusive of fire fighting and improvements, for the total area patrolled is given as follows:

	1914 (*Cents*)	1915 (*Cents*)	1916 (*Cents*)
British Columbia—			
Railway Belt:			
Dominion forest reserves	.46	.52	.70
Dominion parks	.22	.33	.32
Dominion lands	.83	.83	.84
Provincial lands:			
Crown lands	.15	.11	.09
Prairie provinces—			
Dominion forest reserves	.31	.42	.47
Dominion parks	.72	.44	.44
Dominion lands	.07	.08	.09

C. L.

PERIODICAL LITERATURE

BOTANY AND ZOOLOGY

Origin of Species

Paraphrasing parts of a volume published in 1914, *Le Monde Végétal*, by Gaston Bonnier, the reviewer makes special account of the theories of the origin of species. While there is nothing new in these theories, they are clearly stated and argued. There are three theories—the Darwinian theory of evolution, working slowly through centuries or millenniums, which appears largely abandoned; the Lamarkian theory of adaptation under the influence of environment; Naegeli's theory of mutation, the changes being due to disposition in the egg cell. This last theory has been proved as long ago as 1761 by Duchesne, who saw a single-leaf strawberry appear without transition stages from the three-leaved one, which has persisted and propagated its kind. De Vries, Nillson, and Blaringhem have furnished numberless cases of the creation of new species by mutation. But there is in addition open the possibility of the environment producing modifications which become hereditary. Proofs of this are cited at greater length.

Modifications due to a watery environment have been secured in brambles (? ronce!) and in the yellow-flowered water lily (Nuphar) and in other plants, as regards anatomic structure and in character of foliage, amply proving that air plants and semi-air plants are capable of profound modifications to adapt them to live in a watery environment. Just so, plants from a humid region transplanted to a dry climate, and vice versa, change the structure of their foliage, spines, etc. Soil-moisture differences have a well-known influence on plant development. Other modifications result from the chemical character of the soil. Reduction of salt in the soil turns *Matricaria maritima* into *Matricaria inodora*; presence of salt leads to thickening of the leaves due to increase in chlorophyll cells. "A leaf of oats resembles one of wheat more closely if grown with the same mineral constituents in the soil than two blades of wheat grown with different soil constituents." Calcifuge and calcicole plants are often modified from one to the other situations.

Finally, light is a powerful modifier of plant structure and development. Withdrawal of light may change an annual into a perennial plant by developing a rhizome (making the stem grow underground as Constantin has done); transplanting into the snow region of the Alps and into sand-dunes produced the same result. On the other hand, Bonnier by subjecting certain plants to continuous electric light changed their structure and their functions, so that they assimilated and grew at the same time. In a few months change in structure took place that hitherto would have been believed as requiring centuries: pine, spruce, beech, etc., changed structure of leaves so as to lose the characteristics of their genus; the formation of "shade leaves" and "light leaves" different in structure and function is well known. The effects of change in light conditions is practically used by foresters in thinnings. By varying light intensities Maige succeeded in changing straight stems into creeping ones and vice versa (reptation!).

An interesting case of change of habit in northern climate is reported from the peninsula of Kola (Russia), where the railroad engineers found what appeared like young birch reproduction, the branches of birch boles growing underground.

In conclusion, the operation, in combination, of environmental influence and the theory of mutation seems to satisfy most cases; the former readily observed, the latter somewhat more obscure, because the latent characters have in nature rarely opportunity to assert themselves.

The reviewer concludes in arguing for a more circumspect selection of seed and plant material.

Revue des Eaux Forêts, June, 1918, pp. 127-133.

SILVICULTURE, PROTECTION, AND EXTENSION

Insectivorous Bats

Foreseeing that the damaged woods in the war zone, especially the coniferous ones, are bound to be prolific breeding places for insect pests, Jolyet proposes systematic breeding of bats as most assiduous insect destroyers, and as they take the insects in their butterfly stage they do not destroy at the same time the parasites, which are present in the caterpillar stage. He expects to attract the bats by providing suitable resting places for them in the daytime in the form of boxes, the precise construction of which is described. The bats are collected—brought to their habitation, preferably during their winter sleep, in December, when, provided with a warm bed made with hay or straw, they are locked in for several months and become accustomed to their habitation.

Of the two groups of bats, Vespertilio and Vesperugo, the latter are more suitable on account of their life habits. A description of these habits and points of distinction are given, as well as advice how to proceed in making this new assistant in combating insects available.

Cabanes à Chauves-souris. Revue des Eaux et Forêts, June, 1918, pp. 121-126.

Soil Detrimental to Regeneration

In the elegant form and painstaking manner which we are accustomed to see in the publications of the Swedish Experiment Station, Dr. Hesselman reports on his investigation into the difficulties of the regeneration of Scotch pine in the Norrland "pine heaths." The most northern timber forest in Sweden is not, as one would expect, a spruce forest, but an open pine forest, resembling somewhat in its open character our southern pineries, but in drier and rocky condition. The author has observed and reported before on the fact that in these forests regeneration is unusually slow and poorly developed, and he tries to find reasons for this phenomenon. He has made sure that it is not a question of water supply. In his former investigation he had ruled out the influence of the cover of lichen (reindeer moss), but since then has found that under certain conditions and in certain regions, although the forest is quite open, all regeneration, thrifty as well as unthrifty, is lacking over large areas, undoubtedly due to the interference of the dense lichen cover. In these cases, even after the lichen has been removed, the half humified lichen cover which remains prevents the seeds from germinating and getting contact with the mineral soil, so that first mixing of the soil and cover becomes necessary to permit the establishment of pine.

It was suggested that pressure of snow crust had an influence upon the development of the young regeneration, but after careful observation this was proved not to be the case. It was observed that there were at least three conditions under which young regeneration has established itself and grown, namely, in the neighborhood of and under old standing trees, in the neighborhood of fallen stems and tops, and in the more open, treeless areas, which can remain treeless a long time, but which gradually grow to pine. Strangely enough, the best development, as far as numbers and thrift is concerned, was found under the immediate influence of standing trees. The next best development was found under fallen trees and tops, and the openings were poorest, both as to numbers and development. Countings, measurements, and chemical analysis of soil cover brought the conclusion that, while light conditions in these openings were favorable, the openings had a humus cover mainly derived from the lichens (reindeer moss), in which decomposition of the organic nitrogen compounds goes on very slowly; nitrification does not go on, humus nitrogen is not at all, or only with difficulty, to be made available. Under old tops and along decaying fallen trees, as well as under trees standing in the open with much crown, the humus cover has a more favorable composition. The nitrogen of this humus is nitrifiable, but under old tops this nitrification is slow or entirely arrested. Moreover, the plants in the open spots are more liable to insects and parasitic fungi, while under tops and older trees they are somewhat protected against these calamities. Hence in these conditions small groups of young pine establish themselves satisfactorily. The author then concludes that the character of the humus is responsible for the varying conditions of the regeneration. From the practical point of view, to be sure, the propriety of assisting regeneration in these regions by improved nitrogen supply, which could be accomplished by manuring with peat, might not be found practicable.

Studier över de Norrländska Tallhedarnas Föryngringsvillkor—II. Meddelanden Från Statens Skogsförsöksanstalt, 1917, pp. 1121-1286.

MENSURATION, FINANCE, AND MANAGEMENT

Control of Strip Survey

Perhaps the first attempt on a large scale to determine the error of strip survey was made in Sweden and is reported by Hesselman, head of the Swedish Forest Experiment Station.

Sweden, with 52 per cent of its area forest covered, amounting to over 50 million acres, is, perhaps, one of the best wooded countries in the world. The question is whether the woods are overcut, and what the amount of standing timber and the rate of increment might be. In order to approach this problem, a close strip survey was made in one of the provinces, Vaermland, a territory of nearly 5 million acres. The northern part of the province is mostly forest, while the southern part is mixed forest and farmland, so that there are two types of country involved: one, characteristic of the whole of north Sweden, a forest country; the other, mixed, and characteristic of middle and south Sweden.

The strips were laid out in such manner as to cut across the mountain ranges. In the northern part they were 4 km.; in the southern part 2 km. apart and 10 m. broad, so that from .25 to .50 per cent of the whole territory was involved, the whole area estimated amounting to somewhat over 15,000 acres. Every fortieth stem in each diameter-class was taken as a sample tree and its contents and increment determined according to Tor Jonson's method on standing trees. In this way 32,746 sample trees, distributed over the whole country, were more especially investigated. The survey was made with compass and steel tape on the basis of good maps.

We may state briefly the results. The growing stock was found to be 94.5 ± 1.45 per cent cubic feet per acre and the increment 3.54 per cent. It was found that increment and utilization compensated themselves except for the considerable quantity of wood which decays and gets lost otherwise before the stems have grown to use; so that, after all, utilization exceeds increment. The characteristic of the forest conditions of Vaermland is found in the large representation of younger age-classes and small diameter-classes, due to the extensive cutting in the middle and latter part of the last century. The young stands are mostly in good condition.

The most interesting part of the statement is the method pursued to investigate the degree of accuracy of the result, for which purpose a probability calculation was employed. To apply this calculation the strips were systematically divided into pieces 1 km. in length, so that each piece represented 1 hectare (2.5 acres). To give these sample areas symmetrical arrangement, there was laid off from the intersection of a strip, going through the middle of the territory and the middle meridian of the province, a line perpendicular to the strip lines from which intersections the km.-long pieces were measured. These were designated by strip and piece number. In applying the probability calculation these areas were combined into groups, the first group being composed of the areas, numbered 1, 11, 21, 31, etc., the second series numbered 2, 12, 22, 32, etc. In this way the whole estimate was divided into ten independent partial areas, each of which represented one-tenth of the total estimated area, and on this basis the average error of the result was calculated. It appeared that the distribution of areas follows right closely the laws of probability, making a comparison of the survey with the actual areas given on a first-class map of the territory show as follows:

	Area		Average calculated error	Actual error
	Hectares	Acres	Per cent	Per cent
Field	249,520	616,314.40	± 1.27	1.42
Waters	180,022	444,654.34	± 3.68	− 1.41
Forest soil	1,499,328	3,703,340.16	± 0.51	+ 0.31

The actual errors, therefore, lie within three times the average error.

and in most cases less. In spite of the relatively small estimated error, the results, as regards the growing stock, its distribution in diameter-classes and species, its increment, etc., were quite accurate, the average error not exceeding 1.5 per cent, which must be considered a very close result.

It is proposed to make the survey for the whole country in the same manner in the next six or ten years, the cost being estimated at only $160,000 or $170,000.

Die Schätzung des Holzvorrates in den Wäldern des Läns Värmland. Reprint from Internationalen Agrarökonomischen Rundschau, October, 1915, pp. 119-123.

Yield under Management

An interesting note of the results of proper management of one of the city forests of Chur, in Switzerland, is derived from a working-plan revision, such revision being made every 10 years. The city forest of Coire has an extent of around somewhat over 3,000 acres. For the period 1855-1864 the felling budget was 950,000 cubic feet; for the period 1907-1916 it had nearly trebled, to 2,470,00 cubic feet, and a further increase is foreshadowed. To prove that this increase in cut is warranted, the stock on hand by size classes is given in per cents for 1906 and 1917; the cubic contents, with diameters from 6 to 20 inches and over, ran in 1906 as 5, 20, 28, 24, and 23 per cent; in 1917 the diameter classes contained 3.9, 18.2, 27.5, 24.8, and 25.6, showing that the larger sizes participate in the stand at the last date with larger per cents, and the total volume of stand is also slightly larger. It is also of interest to follow the growth of financial results from decade to decade, beginning with 1855-1866, which, to be sure, are also influenced by change of prices (figures rounded off):

	Decade					
	I	II	III	IV	V	VI
Net return per acre........	$1.40	$2.40	$3.15	$3.90	$4.40	$6.00
Expense per cubic foot cut, cents	.034	.08	.064	.08	.084	.13

In about 60 years the net income had increased nearly fivefold, and since the Zurich forests are now yielding as much as $12 per acre, further increases may be expected.

Journal Forestier Suisse, September-October, 1918, pp. 175-176.

UTILIZATION, MARKET, AND TECHNOLOGY

Litter for Paper

Mme. Karen-Branson has devised a method of manufacturing paper from dead leaves by monture (?) and macerating. In discussing this material as a means to meet the paper shortage, it was stated before the Académie des Sciences that in France the annual leaf fall—hardwood foliage only can be used—amounts to between 35 and 40 million tons, while for all the paper needs of France 4 million tons would suffice, furnishing at the same time 2 million tons of by-products. The process is simple, rapid, and cheap; the leaves are crushed and the result is separated into two parts—fibers and powder—the latter furnishing a combustible. The reviewer, in objecting to this threat to use the forest litter, quotes Jacquot as having determined that a fire burning up the litter causes a damage of about $5 per acre; and mentions a chestnut stand in Alsace which furnishes about $8 annually in litter—more than the wood product.

Revue des Eaux et Forêts, July, 1918, p. 152.

Alcohol from Wood Waste

In a paper delivered before the Fourth National Exposition of Chemical Engineers in September, 1918, G H. Tomlinson urges the practicability of the utilization of wood waste for the production of ethyl alcohol. The actual cost of the large alcohol plant of the Standard Alcohol Company at Fullerton, La., is stated to have been, up to the date of June, 1913, approximately $457,-000. Of this sum, about $200,000 represents the outlay for apparatus for the hydrolysis of the hogged wood waste into fermentable sugars or "molasses," the remainder representing the cost of fermenting and distilling apparatus for the recovery of the alcohol. This plant (June, 1913) has a capacity of 370 tons of green-wood waste per day. The cost of producing a sugar solution containing 10.3 per cent of fermentable sugars during a 22-day test run averaged 31.8 cents per hundred gallons. Concentration of this solution to a molasses containing eight times as much sugar increased the cost of production to 3 cents per gallon. Sugar-cane molasses on fermentation will yield ethyl alcohol practically gallon for gallon, while the wood-waste "molasses" will yield only 0.39 gallon of proof spirit per gallon. Due to the much lower cost of the wood-waste "molasses," however, a handsome profit seems to be assured, as it is expected that a price of 12 cents per gallon will be realized in the future. Tomlinson urges the establishment of plants for the production of wood-waste "molasses" at the larger sawmills and the sale of this product to centrally established co-operative fermentation and distillation plants, which must of necessity be under the rigid supervision of the Internal Revenue Department.

B. L. G.

Wood Waste as a Source of Ethyl Alcohol. Jour. Ind. and Eng. Chem., X. October, 1918, pp. 859-861.

Interest in Spruce Turpentine

Paper manufacturers, who during the early part of this year quite generally refused to show much interest in the recovery of turpentine from the waste sulphite liquors, now seem to be eager to install the necessary apparatus for this purpose. It was first pointed out by Klason, in 1900, that spruce turpentine consists mainly of cymene, which can readily be converted into toluol and cumene, which are at present so urgently needed in the manufacture of tri-nitro-toluol and benzoic acid. A recent paper prepared by Schorger, of the Madison Laboratory of the Forest Service, states that various mills have reported a recovery of 0.36 to 1.0 gallons of turpentine per ton of pulp. Schorger finds that sulphite turpentine, consisting largely of cymene, can be used for the production of carvacrol, a compound which is similar in properties to thymol, and toluol.

B. L. G.

Sulfite Turpentine. Jour. Ind. and Eng. Chem., X, April, 1918, pp. 258-260.

STATISTICS AND HISTORY

British Timber Supplies

From an abstract of a lecture by Duchesne on "British Timber Supplies," which is also a plea for the development of a forest policy, we glean the following facts:

During the last 60 years the annual consumption of "timber" in Great Britain had increased from 3.5 to 10.5 cubic feet per capita, and the total imports during that period had increased fivefold, home supplies being almost neglected. The change which has been brought about by war conditions is strikingly illustrated by the following figures, those for home supplies being rough estimates and probably greatly underestimated:

Imports of timber for the years 1913, 1916, and 1917, respectively, ran 11,600,000 tons, 6,300,000 tons, 2,300,000 tons, while native timber felled in these years was, respectively, 1,000,000, 1,250,000, 3,000,000 tons, and the requirements for 1918 were estimated at 6,000,000 tons. In words, the total consumption in the four years of war was almost halved, and the home supplies were trebled and are to be sextupled.

Most of the imports, about 70 per cent, came from Baltic sources, and 50 per cent from Russia alone. The author foresees difficulties in securing such a proportion from these sources after the war in competition with other nations needing materials for reconstruction, and agrees that Canada's export, which in 1913 sent only 10 per cent of the British import, could be greatly increased. The author makes the common mistake in according to Canada "unlimited" timber resources. He also uses the argument of coming scarcity of supplies to support at length the afforestation schemes which have so many years been brewing and which the war experiences may really bring to fruition.

Quarterly Journal of Forestry, July, 1918, pp. 193-203.

Forest Production in France

Pointing out the new significance which forests and forest products have experienced during the war, Arnould insists that better statistics of forest production of France are needed after the war. There are statistics for the years 1882, 1892, 1900, and 1912, which the author analyses, compares, and draws deductions from. It appears that the first three sets of figures do not differ very much, but that the statistics of 1912 show a slight decrease. The forests are divided into three groups, namely, State, communal, and private forests. For State and communal forests the figures are fairly accurate, but for private forests they rely upon uncertain estimates. The total production for 1912 is stated as 830,690,000 cubic feet, of which nearly 30 per cent are workwood. To this is added, for the production from poplars planted along highways and hedges, 63,540,000 cubic feet, making a total of 894,230,000 cubic feet. In the statistics no differentiation is made as to the species involved, excepting for domanial and communal forests for 1892 only, when a differentiation was made into broad-leaved and resinous woods, and within these two groups into wood above 20 inches in diameter and wood less than 20 inches, poles and mine props and fuelwood. In the

State forests the proportion of broad-leaved to coniferous wood is 77 to 23 per cent; in the communal, 81.3 to 18.7 per cent. It is interesting to state that in the State forests the workwood per cent is 36; in the communal forests only 28.8.

An attempt is made to work out the contribution of private forests, which seem largely of coniferous character and to a considerable extent consist of plantations, comprising altogether in the neighborhood of 5 million acres. The pineries of the Landes, comprising 1.7 million acres, are estimated to produce 16,944,000 cubic feet workwood and 51,891,000 cubic feet fuelwood. For the 500,000 acres of other plantations in various parts of the country 3,177,000 cubic feet polewood and 28,240,000 cubic feet fuelwood are estimated. The total production of private coniferous forests, then, is 117,266,600 cubic feet of workwood, poles, and props and 43,207,200 cubic feet of fuelwood. The production of broad-leaved material in private forests is stated as 40,100,800 cubic feet workwood and 366,519,900 cubic feet fuelwood. The totals come out as producing (before the war) in workwood 63,540,000 cubic feet of oak, of which less than one-quarter large size (20 inches and over); 21,180,000 cubic feet of poplar, 16,838,100 cubic feet of various broad-leaved species, and 109,899,000 cubic feet of coniferous woods, of which .4 of large size and 70,600,000 cubic feet of poles, of which .8 is coniferous. The fuelwood amounts to 614,000,000 cubic feet; in round figures, 7,000,000 cords.

The author then makes comparison of these calculations with the figures of a parliamentary report for 1890, showing that this latter report was from 10 to 15 per cent below the present calculations.

Production en matière des Forêts françaises. Revue des Eaux et Forêts, August, 1918, pp. 169-180.

Wood Prices in Switzerland

In May to July, 1918, wood auctions in Switzerland are reported to have brought stumpage values of 40 to 45 cents per cubic foot; sawlogs in the woods ran up to 60 and 70 cents and hardwoods to as much as $1.10 per cubic foot, which may be translated into $75, $90, and $135 per thousand feet, respectively.

Schweizerische Zeitschrift für Forstwesen, June-July, 1918, pp. 151-154.

EDITORIAL COMMENT

Silvicultural Problems in Mixed Forests

The most serious obstacle to the proper handling of the mixed forests of eastern Canada has been the lack of utilization of the hardwood species, particularly birch. This has been especially true as to mixed forest lands held as pulpwood limits, where over vast areas the coniferous species comprise only from 25 per cent to 50 per cent of the stand, the balance being hardwoods. The cutting of the conifers, particularly spruce and balsam, has a constant tendency to convert the stand into a hardwood forest, partly because of the actual reduction in numbers of the conifers, while the hardwoods are left standing, and partly because the coniferous seedlings are prevented from making adequate growth on account of the dense overhead shade of the hardwoods, which spread out and close in the spaces made by the removal of the conifers.

If the hardwoods, particularly birch, could be used to commercial advantage, their removal would permit spruce and balsam seedlings to come in much more satisfactorily and to make a much better rate of growth, on the average, instead of so many remaining suppressed for a long period of time.

The primary reason why the hardwoods have not been utilized in most of our northern forests has been the difficulty of transportation in the absence of railways. Hardwoods are too heavy to be driven long distances in streams without very severe loss by sinkage, and besides the amount of flood water in the majority of driving streams is hardly adequate in volume to float the spruce and balsam to their destination, to say nothing of carrying large quantities of birch in addition. As a consequence birch has remained practically a weed tree over enormous areas of eastern forests where there is no rail transportation.

At last, however, there is a possibility that the problems of transportation may be at least partially solved through the winter use of motor tractors for log-hauling on iced roads. This would apply not only to hardwoods, but to coniferous species as well, where in the case of long drives the loss by sinkage is serious, especially as to the smaller sizes, and more particularly in the case of balsam. Several concerns are experimenting, or are preparing to experiment, along these lines, the River Ouelle Pulp and Lumber Company being the pioneer in this direction as to eastern Canada. The Laurentide Company, Limited, has this year purchased some lighter tractors of the caterpillar type and will this winter experiment under conditions in the St. Maurice Valley. The use of tractors for log-hauling is already established in parts of British Columbia and in various sections of the United States.

The second obstacle to the removal of the hardwoods in our northern mixed forests has been lack of a suitable market, particularly by the pulp and paper companies, which hold rapidly increasing areas of such lands. Formerly only spruce was accepted for use as groundwood in the manufacture of newsprint; later balsam was accepted in an increasing proportion, and now both species are used practically without discrimination. It has always been considered impracticable, however, to use birch or other hardwoods acceptably for groundwood. The Forestry Department of the Laurentide Company has, however, for a long time urged that experiments be made with a view to the utilization of birch in the manufacture of newsprint, and an experiment was recently made by the company which appears to give excellent promise of satisfactory developments along this line. A test run was made, the results of which indicate that up to 10 per cent of birch groundwood can be used to excellent advantage in mixture with spruce and balsam groundwood in the manufacture of newsprint.

It is expected that further tests will be made in collaboration with the Dominion Forest Products Laboratories. Should the final results be satisfactory and should the use of tractors solve the problem of transportation to any material extent, a new era will be opened up in the intelligent handling of our vast areas of mixed forests. It will then be possible to utilize large quantities of birch in the manufacture of newsprint, thus materially relieving the increasing drain upon spruce and balsam, and at the same time leaving the corresponding logged-over areas in good condition for future production instead of constantly depreciating their quality, as has been the tendency under the only methods of operation hitherto considered feasible. Should these developments come to pass, forestry will find an immense scope for activity in our northern forests, replacing, at least in part, the destructive methods so generally practiced heretofore.

C. L.

Timber Supplies of the United Kingdom

The experiences of the war may advance forestry ideas more rapidly in Great Britain than all pre-war propaganda. The forestry section of the British Empire Producers' Organization recently issued a report on the subject. A special committee was appointed in March, 1918, to consider and report on the question of forestry and the immediate timber supplies of the United Kingdom. On June 3, at a conference instigated by this organization, a resolution to the following effect was passed and forwarded to the Government:

"That this conference is of opinion that it is in the national interest that the Empire should, as far as is possible, be rendered self-supporting in essential commodities, and that arrangements should be made without delay for the supply of timber for building and other purposes, to be obtained from sources of supply within the Empire.

The committee was empowered and drew up a memorandum dealing with the whole question of timber supplies of the United Kingdom. They submitted the following to the Government for consideration:

1. The total area under woodland in the United Kingdom before the war was estimated at 3,000,000 acres; the annual yield from which is believed to have been 45,000,000 cubic feet.

2. The average annual imports of timber similar in character to that produced in the British Isles were equivalent to 550,000,000 cubic feet of standing timber. The home production, therefore, was less than 8 per cent of the consumption of these classes of timber.

3. In order to render the United Kingdom independent of imported timber for three years in an emergency, it is necessary, while making due allowance for an improved yield from existing woodlands, to afforest 1,770,000 acres.

4. The United Kingdom derives 80 per cent of its imported timber from foreign countries. The largest reserves within the Empire are to be found in Canada, Newfoundland, Australia, and India.

Unless arrangements can be made with the Dominion governments for the effectual conservation and utilization of these reserves, it is a matter of urgent importance that provision should be made within the British Isles on a far larger scale than has been proposed above for the purpose of defense. Reference should here be made to the report of the Royal Commission on Coast Erosion, of 1909, whose recommendations contemplated, *inter alia*, the afforestation of 9,000,000 additional acres in the British Isles.

A study of the question shows that we are the largest importers of timber of any nation, and therefore we are the most dependent on forests abroad and the most interested in the conservation and utilization of the forests of the Empire.

The British Empire Producers' Organization advocate that the following policy be adopted forthwith:

In view of the extreme urgency and uncertainty as to the question of our timber supplies, such forest authority should be appointed immediately to consider and deal with the whole subject.

The organization is satisfied that in order to encourage the investment of capital necessary for the development of large supplies, certain guarantees, including permanent security of market, will be looked for.

NOTES

Timber Census of New York State

When the Society of American Foresters, through its war committee, began a survey of timber supplies in the Northeastern States, the United States Forest Service was so impressed with the value of this survey that it determined to expand the project into a complete timber census. In New York State a subcommittee, consisting of C. R. Pettis, Superintendent of State Forests, and Prof. A. B. Recknagel, Forester and Secretary to the Empire State Forest Products Association, had begun the good work in May. To them, in July, came K. McR. Clark, of the United States Forest Service, and plans were made for a complete timber census of the State. There existed no list of timber-land owners, so the first step was to obtain from the supervisor of each town a list of names and addresses of those owning more than 50 acres of woodland in their respective towns. There are 900 odd towns in the State and, almost to a man, the supervisors have complied with the request. Thus there exists for the first time a list of over 5,000 timber-land owners in the State, alphabetically arranged by towns and counties. Next a timber-estimate blank, asking each owner by township to report his holdings by species in feet and cords, board measure, and an appropriate letter of transmittal, were sent to every name on the list. The letter was signed by George D. Pratt, Conservation Commissioner of the State, and went under Government frank as official business. A franked addressed envelope, which required no postage, was inclosed for the owner's reply. There was also inclosed a card urging the woodland owner to produce more cordwood against the impending fuel shortage next winter. When these 5,000 or more replies have been received they will be carefully tabulated by the United States Government in order that it can, as necessity arises, make immediately available the timber resources of the State for the production of war material. That the Empire State is the leader in this project, as in so many other war-time activities, is greatly to its credit. The other Northeastern States are following suit, so that before long the Government will have an authoritative answer to the oft-repeated question, "How much standing timber is left in the East?" In due time the information so collected will be published without, of course, giving any names, but only general totals, which in no way reveal individual estimates.

Danish Forest Experiment Station

In 1883 there was established in Denmark a section for research in forestry, as a branch of the office for the management of State forests. This arrangement continued down to 1901, when the Minister of Agriculture organized the station for forestry research. The management is in the hands of a chief of station, in conjunction with a commission of two representatives of the forest administration, two representatives of private forestry, and one representative of forest instruction. The members of the commission are nominated by the Ministry of Agriculture except those representing private forestry who, in the first instance, are proposed by the directing council of the forest society. The chief of station is a permanent member of the commission and acts as president; he also acts as editor and is responsible for the accounts. With regard to the other members of the commission, one member must be re-elected every two years. The commission meets once yearly at least. It settles the plan of work for the coming session and draws up the budget. It reports upon the work of the preceding session. It has the power to entrust the direction or execution of a piece of work to a person other than the station chief, although in case where the nature of the work demands continuity it shall be the station chief who has preference. The commission may consult technical men and invite them, if necessary, to attend their sittings, in case where they are deemed specially competent to deal with some special question. The station for forest research now has its office at Copenhagen, near the higher school of agriculture, and its experimental nursery (13½ acres) at Hegelund, 35 kilometers from Copenhagen. This latter possesses a little wooden building containing the workmen's quarters and an office. Up to the present the station has published four volumes (1905-1915) of reports. Beginning with the fourth volume, the reports, printed in Danish, are accompanied by summaries in English, French, and German. The following is a list of subjects dealt with up to the present: Growth and yield of forest trees; trials of foreign species; researches on forests soils, and particularly the forms of humus and soil biology; mechanical and chemical analyses combined with trials on the application of artificial fertilizers to spruce, Scots pine, fir, and oak in heath soils; the action of storms on forest trees; races and forms of forest trees; control of diseases of forest trees; management, thinning, and repopulating of beech; manufacture and employment of wood for joinery and fuel; easy and economic methods of mensuration of timber. — *Det Forstlige Forsogsvaesen i Danmark.*

Further Notes on Rock Elm

The notes on rock elm, which appeared in last month's Journal, stated the opinion that most of the commercial rock elm of Wisconsin and Michigan was not identical with the true rock elm, or cork elm (*Ulmus racemosa*), but was only a denser wooded form of white elm (*Ulmus americana*). This was a wrong conclusion. Later information shows beyond question that the bulk of the commercial supplies of rock elm are in reality *Ulmus racemosa*. This correction had been supplied considerably before the last issue of the Journal went to press, but had not been brought to the Editor's attention. The mistake arose mainly through attaching too much importance to the roughness of the twigs as a distinguishing character. This feature is inconspicuous or lacking in large rock-elm trees in the forest. The attempt to distinguish a dense-wooded, high ground form of white elm is therefore erroneous, and the description of such a form given in the previous notes should be understood to apply to the true cork elm.

From the available data, it seems probable that the annual cut of rock-elm lumber in Wisconsin is close to one-quarter of the total cut of elm lumber of all species, amounting probably to about 10,000,000 board feet. The largest supplies are found in a strip embracing all or parts of the following counties: Oconto, Langlade, Shawano, Marathon, Taylor, Clarke, Chippewa, and Eau Claire. At a few mills in Shawano, Langlade, and adjacent counties it may form half or even a greater part of the annual cut of elm. The commercial range extends considerably farther north of the limits shown for it in the map of distribution given in Department of Agriculture Bulletin 683. In lower Michigan the supply is practically exhausted as a result of many years selective cutting of rock elm for ship timbers. Here, again, the range extends farther north than as shown on the map above mentioned. In the vicinity of Cadillac there are second-growth woodlots in which rock elm of good quality is the predominant species, and it is a conspicuous roadside tree.

E. H. Frothingham.

Influence of the Perennial Lupin

Fifteen years ago, in the forest district of Haid (western Bohemia), an experiment was started to test the influence of the perennial lupin (*Lupinus perennis* L.) on the development of forest trees in poor soils. Two plots were planted with spruce, one with and another without lupin. The plot with lupin showed better growth than the one without lupin. Ten years after planting (1911), the trees in the lupin plot were 1.63 meters high against a height of only 1.02 meters for those in the plot without lupin; both lateral branches and needles of the former were longer than those of the second plot. These differences were confirmed during the period 1911-1916.—*K. Nawratil, Centralblatt für das gesante Forstwesen.*

The recently completed study of climatic control of forest types made under the auspices of the Experiment Station in Missoula claims to have found that the different forest types are confined to regions with given summer temperature and given annual precipitation, and that the excess or deficiency of either become limiting factors. On the basis of this study yellow-pine forests require a summer mean of from 60 to 65 degrees and rainfall of from 14 to 19 inches per year. Lodgepole pine-Douglas-fir forests require a summer mean of but 54 degrees; western white pine and larch-Douglas fir a little less. Prairies result whenever the yearly downpour falls below 14 inches, regardless of the temperature. The western white-pine region has a lower July and August rainfall and humidity and greater amount of sunshine than any other section of the district. This probably explains why fires become more dangerous here than elsewhere in the latter part of the summer. A more luxuriant vegetation is also found here. The study seems to bring out clearly that the three east and west District sections have their own distinct rainfall type. The type west of the Bitterroots shows a January and November high precipitation characteristic of the Pacific Coast type, but also a high precipitation in May. The Flathead and Bitterroot valleys have the same type of precipitation, but lesser amounts, while east of the Continental Divide there is no January and November high-point precipitation, but a greatly increased May and June downpour, which is a part of the continental type of rainfall.

The demand for chemicals derived by distillation from wood has been greatly stimulated by the war for war uses directly and as a consequence of the cessation of German imports. Among the uses directly for war purposes may be cited the manufacture of acetic acid and acetone, used as a solvent in the manufacture of explosives. Among the uses which will continue after the war to call for wood derivatives may be mentioned: Acetone, as a solvent in the production of moving-picture films and for gums used for industrial purposes; acetic acid, its commercial use, including paint and white-lead manufacture, and the bleaching and dyeing industries; acetate of soda, used in textile industry; wood alcohol, used in connection with the aniline-dye industry and also in the manufacture of soaps, perfumes, and methylated spirits; formaldehyde, used also in the manufacture of aniline dyes and in large quantities as a preventative of smut on grain. The establishment of the soda-ash industry in western Ontario will enable Canadian enterprises to expand on lines that were formerly closed to them. New processes have been evolved for the manufacture of acetone. The old process was by the distillation of acetate of lime, a by-product in the manufacture of charcoal and still the most general source of acetone. One of the new processes involves the treatment of calcium carbide.

Shell boxes manufactured in Canada for the Imperial Munitions Board from the autumn of 1914 to September 30 last are valued at $26,000,000. The official figures show that the quantity of boxes manufactured during that period was 22,470,000. Ammunition-box manufacture contributed to a large degree toward maintaining stability in the wood-working industry during the early period of the war. It was not long before 175 to 200 concerns were in the market for munitions-box contracts. Furniture manufacturing establishments, planing mills, and sash and door factories were all eager to engage in the production of shell boxes. About 24 types of boxes have been manufactured for the British Government, including hundreds of thousands of T N T and cordite boxes, as well as smokeless-powder boxes. Six-inch howitzer shell and 18-pounder shrapnel boxes were probably the most numerous. The average percentage of moisture contained in the lumber when delivered must not exceed 15 per cent of its weight. Each lot of lumber submitted by the manufacturer as being fit for use in shell boxes has to be examined by a Government inspector, and a favorable report on the moisture content has to be received before the boxes can be shipped.

The British Reconstruction Committee (under a minister of reconstruction, with some 80 subcommittees), by its forestry subcommittee, recommends a central forest authority, equipped with funds and powers to formulate a comprehensive forest policy, and especially carry out an ambitious reforestation plan. The report of this subcommittee has provoked recommendations of suggested procedure from various quarters, published in the *Quarterly Journal of Forestry* for July. One writer, Adkin, reviews interestingly the muddle in which the existing laws relating to forestry are, dating to the Middle Ages, when no trees but oak, ash, and elm were defined as "timber," and silvicultural methods were undeveloped. These laws will have to be abolished before a planting campaign by private owners, which the writer advocates, can be successfully inaugurated. Loans to would-be planters and arrangements "whereby such planters will not lose by doing so" (how?) are advocated.

The quantity of peat sold in the United States in 1917 exceeded that sold in any preceding year. There were sold 97,363 short tons—a quantity greater by 44,857 tons than that sold in 1916 and by 42,220 tons than the record annual sales established in 1911. The gross market value of the output was $709,900—a gain over 1916 of $340,796, or about 92 per cent in market value. The average price received in 1917 at the point of consumption was a little more than $7.29 a ton. The total number of plants producing peat in 1917 was 18—an increase of 5 over 1916. Improvements designed to increase production in 1918 were made to substantially all the peat plants operated in 1917. The plants known to be at work in 1917 were distributed as follows: California 2, Florida 2, Illinois 2, Indiana 1, Massachusetts 1, New Jersey 5, New York 3, Pennsylvania 1, and Virginia 1.

The reconstruction of forests in France is not only being discussed, but has been actively begun. L'Administration des Eaux et Forêts is already enlarging its nurseries in view of the extensive planting program which will have to be taken up immediately after peace is declared. The latest development in this direction is the formation of the Société Forestière du Rouergue, with a capital of $40,000, an association of gentlemen for the purpose of buying up or acquiring otherwise waste lands for reforestation. The association has already acquired one area of 500 acres, or thereabouts, paying for it $2,000. The administration will, of course, advance the objects of the association as far as possible.

The fact that American woodturning plants which formerly turned out these products are now engaged almost entirely on war work has given the Canadian industry a great opportunity for expansion and a fair amount of export business, especially in wooden knitting needles, parts for dolls, and turned toy parts. Wooden nose plugs for shells, both for British and American use, make the manufacture of wood-turnings a semi-war industry. Paint-brush handles are one line of staples that promise particularly well for after-war trade. Shaving-brush handles are in demand in large quantities for the American Government, and over two million are being supplied to meet the needs of the United States Army.

A census for 1917 of the pulp and paper industry throughout Canada by the Dominion Bureau of Statistics embraces 80 concerns, of which 31 were engaged in the manufacture of pulp only, 26 in the manufacture of paper only, and 23 manufacture both paper and pulp. The total capital invested in this industry, including lands, buildings, machinery, stocks on hand, and working capital, amounted to $186,374,905. The total number of employees on wages was 20,685 males and 671 females; on salaries, 1,345 males and 218 females. The total salary and wages bill was $20,344,286. The average value of production in 1917 was $96,248,834.

On August 18 of this year died the nestor of our profession, in his ninety-seventh year, Dr. J. Coaz, in full possession of his faculties and active to the last in literary direction. Dr. Coaz resigned his position as head of the Swiss federal forest service only four years ago after forty years' incumbency of that position. He was the originator and organizer of that service. It is interesting to note that he was a student under Cotta and Pressler.

Old names are changed to new names, if the old have the taint of German derivation in them. Thus the long-established preservative, *Carbolineum avenarius*, has been changed to protexol without change in composition, and is still manufactured by the Carbolineum Wood Preserving Company, in New York City. The value of this preservative for brush treatment is so well known to our readers that there is no need to do more than refer to the literature issued by the company in circulars. Circular 86, lately issued, treats more especially on pole-timber economics.

The Quebec Limitholders' Association has appointed a committee to recommend a scheme of reforestation to the Provincial Government and to press legislation on the subject.

SOCIETY AFFAIRS

Meeting of the New York Section, Friday, September 6, 1918

Called to order at 10 a. m. by Secretary Recknagel, in the absence of Chairman Pettis. Following were present: Messrs. Bentley, Gaylord, Hosmer, Kellogg, McCarthy, Recknagel, and Sterling. Hosmer was appointed temporary chairman.

Hosmer reported for committee on membership; this was a preliminary report on the following for membership in the Society: Seward Smith, Robert Craig, H. H. Tryon, E. G. Dudley, H. C. Balyea, H. L. Henderson, C. H. Guise, G. H. Collingwood, Donald White, E. W. Blue, J. D. Lamont, Karl Schmidt, R. G. Stubbs, K. F. Williams, B. H. Paul, D. E. Lauderburn, A. C. Volkmar, and Warwick Carpenter.

Hosmer and others moved the endorsement by the Section, which was seconded and carried, of the following for senior membership: Messrs. Collingwood, Dudley, Guise, Lamont, Paul, Schmidt, Volkmar, and White; and for membership, Messrs. Stubbs and Williams. Action was suspended on other possible members and referred back to committee on membership.

Action on the name of Warwick Carpenter for associate member was left to the committee on membership, with power to act.

The name of Louis Agassiz Fuertes for associate membership was suggested to the committee on membership.

Sterling suggested that in sending out calls for future meeting they be sent out earlier, and that at least two subsequent notices be issued as reminders to members of the impending meeting.

Kellogg moved that Recknagel prepare a paper on the timber census, to be presented at the meeting of the American Association for the Advancement of Science in Baltimore this winter, to be read by him if possible; if not, then by some other delegate present.

Letter to Ridsdale about the Section's contribution to the welfare fund for lumbermen and foresters in the War Service and also his reply thereto read and placed on file.

Secretary reported on the progress of the timber census in this State.

Resolution on Moody's death left to Hosmer and Recknagel, with power to act.

Paper read by McCarthy on "Knot Zones and Spiral in Adirondack Red Spruce" was most favorably received.

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