DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

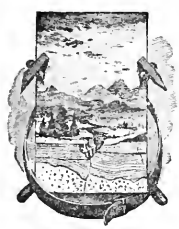
THE

MOUNT RAINIER FOREST RESERVE, WASHINGTON

BY

FRED G. PLUMMER

EXTRACT FROM THE TWENTY-FIRST ANNUAL REPORT OF THE SURVEY, 1899-1900
PART V, FOREST RESERVES—HENRY GANNETT, CHIEF OF
DIVISION OF GEOGRAPHY AND FORESTRY



WASHINGTON
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MOUNT RAINIER FOREST RESERVE, WASHINGTON.

By Fred G. Plummer.

BOUNDARIES.

By proclamation of the President made February 22, 1897, the Mount Rainier Forest Reserve was established with the following boundaries:

Beginning at the southeast corner of township four (4) north, range (9) east, Willamette base and meridian, Washington; thence northerly along the range line between ranges nine (9) and ten (10) east, subject to the proper offset on the first (1st) standard parallel north, to the northwest corner of township six (6) north, range ten (10) east; thence easterly along the township line to the northeast corner of said township; thence northerly along the range line to the northwest corner of township seven (7) north, range eleven (11) east; thence easterly along the township line between townships seven (7) and eight (8) north to the northeast corner of township seven (7) north, range twelve (12) east; thence northerly along the surveyed and unsurveyed range line between ranges twelve (12) and thirteen (13) east, subject to the proper offset on the second (2nd) standard parallel north, to the northwest corner of township eleven (11) north, range thirteen (13) east; thence easterly along the surveyed and unsurveyed township line between townships eleven (11) and twelve (12) north to the southwest corner of township twelve (12) north, range fifteen (15) east; thence northerly along the surveyed and unsurveyed range line between ranges fourteen (14) and fifteen (15) east, subject to the proper offsets on the third (3rd) and fourth (4th) standard parallels north, to the point for the northeast corner of township eighteen (18) north, range fourteen (14) east; thence westerly along the unsurveyed and surveyed township line between townships eighteen (18) and nineteen (19) north to the southwest corner of township nineteen (19) north, range seven (7) east; thence southerly along the surveyed and unsurveyed range line between ranges six (6) and seven (7) east, subject to the proper offsets on the township line between townships seventeen (17) and eighteen (18) north, and on the fourth (4th), third (3rd), and second (2nd) standard parallels north, to the point for the northeast corner of township five (5) north, range six (6) east; thence westerly along the unsurveyed township line between townships five (5) and six (6) north to the southeast corner of township six (6) north, range four (4) east; thence southerly along the unsurveyed range line between ranges four (4) and five (5) east, subject to the proper offset on the first (1st) standard parallel north to the point for the southwest corner of township four (4) north, range five (5) east; thence easterly along the unsurveyed and surveyed township line between townships three (3) and four (4) north to the southeast corner of township four (4) north, range nine (9) east, the place of beginning.

Excepting from the force and effect of this proclamation all lands which may have been prior to the date hereof embraced in any legal entry or covered by any lawful filing duly of record in the proper United States land office, or upon which any valid settlement has been made pursuant to law, and the statutory period within which to make entry or filing of record has not expired, and all mining claims duly located and held according to the laws of the United States and rules and regulations not in conflict therewith:

Provided, That this exception shall not continue to apply to any particular tract of land unless the entryman, settler, or claimant continues to comply with the law under which the entry, filing, settlement, or location was made.

GENERAL DESCRIPTION.

The tract thus reserved includes the Cascade Range in the southern part of Washington. The Government land surveys which partly bound and fix the location of the reserve have in western Washington been made from the Willamette meridian and in eastern Washington from the Columbia guide meridian. The sum of the discrepancies between them falls in the unsurveyed mountainous region partly covered by the reserve, and for this and other reasons the area of the reserve is 2,146,600 acres, and not 2,234,880 acres, as would be implied by the above description if all the townships were of full size. Of this total area 890,440 acres, or 41.4 per cent, lies on the eastern slope, and 1,256,160 acres, or 58.6 per cent, on the western slope of the mountains.

These two slopes, which will be often referred to in this report, present widely divergent conditions in climate and flora, but they share a bold topography in common. The line dividing these slopes, or the line separating the eastern drainage from the western, has a general direction of N. 5° E. Its detailed meanderings within the reserve are delineated on the map, Pl. XXXIII.

All of the eastern slope and the greater portion of the western drain into Columbia River, the tributary streams being the Cowlitz, Cispus, Lewis, Washougal, Rock, Wind, Little White Salmon, White Salmon, Klickitat, Atanum, Tieton, Naches, and Yakima rivers. The total watershed area of these streams is 1,794,600 acres, or 83.6 per cent of the reserve. The remainder, 352,000 acres, or 16.4 per cent, is drained into Puget Sound, the tributary streams being the White, Puyallup, and Nisqually rivers.

Within the reserve are four mountain peaks or domes of unusual magnitude: Mount Rainier, 14,526 feet; Mount Adams, 12,470 feet; Goat Mountain, 8,500 feet, and Mount Aix, 7,623 feet. Of these Mount Rainier and Mount Aix are not on the summit line, but like Mount St. Helens, Mount Stewart, and Mount Baker, all in Washington, stand on one side or the other of the range.

The glaciers and perpetual snow fields of Mount Rainier have a total area of 32,500 acres, and are therefore an important item in the estima-

A. MOUNT RAINIER AND LONGMIRE SPRINGS.

B. MOUNT RAINIER.

tion of areas without timber. The glaciers of Mount Adams cover only 2,300 acres, and those of Goat Mountain are insignificant. In unusual summer seasons, such as that of 1899, small areas of high altitude, protected from the warm chinook winds, may remain snow covered, but the perpetual snow fields and glaciers within the reserve are limited to Mount Rainier and Mount Adams. Probably an exceptionally warm season would leave no ice or snow on Goat Mountain.

The routes of travel in the reserve are few. Most of the trails shown upon the map are hardly deserving of the name, but indicate blazed lines where better progress can be made than by taking a course through the timber and brush. The Indian's policy was to go only where his pony could take him, and the idea of cutting and logging out a trail was repugnant to him; therefore his lines of travel were along the sparsely timbered ridges, where feed was generally plenty, where game abounded, or where huckleberries grew. Later came the prospectors and sheepmen, and in some places they did considerable work. Since the advent of settlers in the valleys of the Nisqually, Cowlitz, Wind, and Little White Salmon, wagon roads have been built and the larger streams bridged. Since 1896 stages have run from Tacoma to Longmires Springs during July, August, and September of each year to accommodate the tourist travel en route to Paradise Park. Twelve miles of this stage road is inside of the reserve and was constructed on a county survey prior to the proclamation of the reservation. Public sentiment strongly favors the opening of this scenic region by better lines of travel than the poor wagon road and pack trails. The Yellowstone and Yosemite will have a strong competitor when this is done. The setting aside of nine townships around Mount Rainier as a national park was an act which met with universal approval.

CLIMATE.

Accurate meteorological data are not obtainable regarding that portion of the Cascade Mountains within the boundaries of the reserve, as the Weather Bureau has never had an observer in that area. During the examination a large amount of fragmentary information was collected from settlers, prospectors, and trappers, and by personal observation. This has been used, with many interpolations, in the preparation of the accompanying maps.

The bold topography of the reserve is the cause of wide diversities in climatic conditions, some of which are general and affect large areas, while others affect only small areas. The rain-bearing clouds are brought by southwest winds from the Pacific Ocean, and find easy access to the Cascade Range through breaks in the Coast Range. The mountains along the coast, owing to their position and height, are great rain producers for their own areas, but the range is not continuous and the gaps in it are low. Important among the gaps, as affecting the region under consideration, are those made by Grays Harbor, Willipa Bay, Columbia River, Tillamook Bay, and Yaquina Bay.

The Cascade Range, running north and south, parallel with the coast, presents a more continuous barrier to the rain-bearing clouds, the only break or gap being that through which Columbia River flows.

The winters in the mountains are long rather than severe. Doubtless upon such elevations as Mount Rainier, Mount Adams, or Goat Mountain the prevailing conditions during the winter are of extreme severity.

A strong contrast is presented between the corn and tobacco fields of the Cowlitz Valley and the ice fields and glaciers of Mount Rainier, and yet among these same glaciers in the mountain parks a profusion of wild flowers and grasses results from the mild and delightful climate that prevails during the short summer season. It is always a matter of surprise to the tourists that they may camp in summer gardens surrounded by arctic scenery on such a grand scale, but this camping season is limited to July, August, and September.

During 1886, 1887, and 1888 the engineer department of the Northern Pacific Railway kept a weather record at Stampede Pass tunnel, and from those observations the following table has been compiled:

Average temperature and snowfall at Stampede Tunnel, Washington, for 1886–1888.

[Altitude, 2,840 feet.]

Months.	Greatest depth of snow.	Temperature.	
		Highest.	Lowest.
	Feet.	*Degrees.*	*Degrees.*
January	8.9	42	10
February	7.5	47	16
March	7.5	55	20
April	5.5	61	41
May	2.6	77	35
June	....	72	43
July	....	86	48
August	....	82	51
September	....	76	40
October	.2	62	32
November	1.1	50	19
December	3.6	42	18

A. NARADA FALLS, PARADISE PARK.

B. ICE CAVES.

ARABLE LANDS AND SOIL FORMATIONS.

Only about 45,000 acres or 2 per cent of the entire reserve is fair farming land, and of this amount more than one-half is under adverse climatic conditions due to great altitude and exposure.

Of the favorably situated areas in western Washington the most important is the Cowlitz watershed.

The Cowlitz Valley widens for a length of 13 miles within the reserve and includes some very good land known as the "Big Bottom," which contains about 12,000 acres, of which 25 per cent is slashed and partly cleared. The soil formation, as shown by the wells and river banks, averages as follows:

Section in Cowlitz Valley, Washington.

	Feet.
Sand or sandy loam	1.0
Scoria sand	.5
Sand and sandy loam	12.0
Gravel and sand	4.0
Scoria sand	2.0
Clay and sand.	

Bear Prairie, in sec. 8, T. 14 N., R. 8 E., at the head of Snake Creek, in the same watershed, contains about 90 acres of good hay land and has been drained by the claimant. The formation as shown by the ditching is as follows:

Section in sec. 8, T. 14 N., R. 8 E., Washington.

	Feet.
Sandy loam	1.0
Scoria sand	.1
Sandy loam	1.25
Scoria sand	1.0
Sandy loam.	

The Nisqually below the mouth of Horse Creek has an area of about 4,000 acres, of which 30 per cent is a liberal estimate of the arable portions. The balance of the bottom lands are either rocky, gravel, or clear-washed sands, with little soil or humus. The areas which are arable are covered with thick stands of forest and it costs $100 to $150 per acre to prepare them for the plow. The settlers on these lands often leave the stumps in their fields and garden patches.

On the South Fork of Puyallup River, on which no settlement has been made, there are about 300 acres of arable land in scattered patches which would be difficult to clear.

The Mowich River bottom inside the reserve has about 1,000 acres of very fair land which is heavily timbered.

The Carbon River Canyon is uninviting to the farmers. The steep side hills run almost to the river and a few little patches of good soil are all that can be mentioned. The same is true of the White River Canyon.

In the valley of Cispus River, below the mouth of Anatass Creek, there are about 1,000 acres of arable bottom and bench lands in scattered tracts. The same scoria sand found in the Cowlitz and other watersheds is present. In sec. 2, T. 11 N., R. 7 E., a well 5 feet deep in a swale showed the following:

Section in sec. 2, T. 11 N., R. 7 E.

	Feet.
Scoria sand	1
Black muck	4
Coarse sand.	

The valley of the Lewis River within the reserve is a canyon at its lower end, and those areas nearer the headwaters are of too great altitude to be of any use.

Wind River Valley is low and broad and contains about 8,000 acres of good land but difficult to clear. Being easily accessible from Columbia River, this area has found many settlers.

The same is true of the valley of the Little White Salmon River, which contains about 2,000 acres. The timber is smaller and has been partly removed by logging and railroad-tie cutting. In the White Salmon River Valley about 2,000 acres might be made profitable by irrigation, but the season would be short.

In the Klickitat watershed lying between the Fish Lake Stream and the Clearwater is about 2,500 acres of moist bench land. It would cost $75 per acre to prepare it for the plow, and by reason of the severe winters and short summers it would be of doubtful value. Bordering the Klickitat and the Lower Fish Lake Stream in Ts. 8 and 9 N., R. 12 E., there is an area of about 10,000 acres of bench land supporting a growth of yellow pine (*Pinus ponderosa*) and pine grass (*Calamagrostis suksdorfii*). When cleared it would be fair land under irrigation.

On the headwaters of the main Klickitat River are a series of meadows which will aggregate about 800 acres. The level bottom and low benches of fair land bordering these meadows may be classed as arable land and will add 1,200 acres to the above, making a total of 2,000 acres. These bottoms are divided transversely by several low ridges both in appearance and formation strongly suggestive of terminal moraines of an ancient glacier. No striæ were noted.

Conrad Meadows, on the South Fork of Tieton River, contain about 400 acres which should be drained.

At the head of Tannum Lake on Bumping River is about 500 acres of bottom land with a growth of young fir, hemlock, cedar, and light underbrush. Small areas of this bottom are timberless and grassed.

Other small and unimportant areas of arable land are Goose Prairie on Bumping River and Pleasant Valley on American River, and also a few benches and small lake beds on the Naches and Tieton rivers.

A. TATOOSH RANGE; MOUNT ST. HELENS IN DISTANCE.

B. SMALL LAKE NEAR INDIAN RACE TRACK, SECOND GROWTH OF MOUNTAIN FIR A'. HEMLOCK

Near the headwaters of many of the smaller streams are small meadows, but their elevation and exposure forbid their use for agricultural purposes.

The surface soils other than above detailed are entitled to only brief mention. The bold topography of the area prohibits the accumulation of deep or rich soils. The underlying ledges, talus, and gravels are covered with sand, resulting from decomposition, and over many areas with scoria. This scoria is both of interest and value. Some samples were taken from an undisturbed bank on a hill in the SE. ¼ of SE. ¼ of sec. 18, T. 12 N., R. 7 E., and gave a weight of 49.55 pounds avoirdupois per cubic foot. After being screened a cubic foot of the sand, whose grains ranged in size from one-half to one-eighth inch in diameter, weighed 43 pounds. The same screening after being dried weighed 37.4 pounds.

This sand follows the surface of the country, and in the higher elevations is often exposed, and over small areas has been recently eroded. Its color is a dull straw, sometimes deep brown. It is very coarse, gritty, and free from loam and other foreign matters, and is never waterworn. It is always loose, never compact. When exposed to air by the plow it undergoes a slow slaking process, and is regarded as remarkably fertile soil. In Cowlitz Valley John Blankenship says his field of sand changed very much by working, as it decomposed, turned yellow, and made good soil, which he has used for growing artichokes. His flower garden blooms freely, but the plants are not thrifty. Scoria sand taken from his well was thrown over the surface of the ground, and showed its fertility by the growth of weeds which followed.

All of the evidence presented by the scoria sand points to the probability of its being the result of a recent volcanic eruption, but to name the volcano or to fix the date will require more extended examination.

COAL INDICATIONS.

The Columbia River lava (Miocene) has overcapped and almost completely buried the coal-bearing strata (Eocene) within the reserve. Rarely has erosion uncovered the upper measures, which are found badly faulted and broken, and in several cases metamorphosed by heat.

Eocene sandstone and fossil-bearing shales were recognized near the southwest corner of sec. 18, T. 17 N., R. 8 E.; also on Goat Creek, Coal Creek, and Sweetwater Creek on the Nisqually watershed. The fossils are the leaves of alders, maple, and willow and resemble those found in the roof rocks of the Roslyn coal mine in eastern Washington and in other coal mines on the west side of the range. Coal float was found at these localities. Fossil leaves are also reported from the Wind River watershed, near Lookout Mountain.

The Davis coal prospect on Summit Creek has been worked to a small extent to determine its value. A vein 6 feet wide is claimed, which crosses Summit Creek, and is exposed on both sides of the canyon. The improvements consist of two small cabins, a shaft about 10 feet deep, and two tunnels.

Coal veins exist in secs. 13 and 14, T. 12 N., R. 8 E., and some prospecting has been done, but the work has been abandoned. Two miles north of Packwood Lake several small coal veins have been prospected.

On the headwaters of Cispus River, in T. 10 N., R. 10 E., several coal veins have been prospected, but no real development work has been done. Traces of coal have been found underlying the basalt at Steamboat Mountain.

MINERALS AND MINING CLAIMS.

The Columbia River lava is not a favorable formation for the deposition of the precious metals in paying quantities, although waters slightly charged with minerals have deposited gold, silver, lead, iron, and silica along cleavage planes in the high country rock, which is mainly diabase capped with lava. On the surface where these infiltrations occur the original sulphide deposit has been oxidized and concentrated, so that by panning some color of flour gold can be obtained. Below the line of oxidation, at a depth of about 30 feet, the mineral deposit changes to low-grade iron pyrites, which requires smelting and is not of sufficient value to make it profitable to mine.

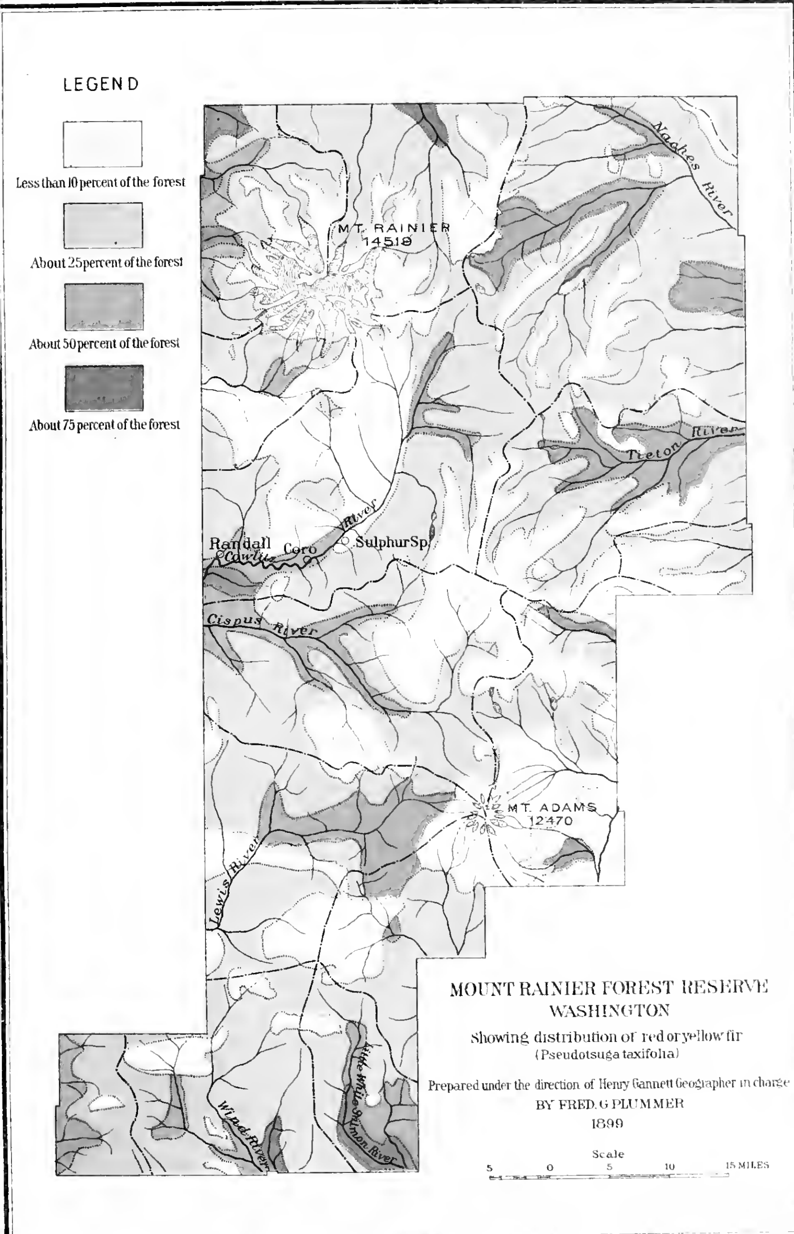
These veins do not show any characteristics of true fissure or contact fissure veins, there being no ribbon structure of the vein matter or striation of the walls, but merely an impregnation of the country rocks, which would indicate that they are merely gash veins which will in all probability terminate at a slight depth.

The placer ground on Moore Creek, at the base of Gold Hill, is said to give colors to every pan, but inasmuch as several parties have operated it in years past and have given it up it can not be very profitable.

The Medina Mining Company is building a 5 stamp mill on the west side of Silver Creek to test the free or oxidized ore. On the opposite side of the gulch the Florence Company is running a crosscut tunnel easterly in diabase rock for the purpose of tapping some ore veins that crop on the slope of the mountain above. If the company is successful in this it may prove that the veins at this point have depth and are not gash veins in the cleavage of the country rock.

MINERAL SPRINGS.

James Longmire patented 20 acres of land lying in secs. 29 and 32, T. 15 N., R. 8 E., as a mineral claim. He erected an inn, barn, two bath houses, one storehouse, and two small shacks.



JULIUS BIEN & CO. LITH. N.Y.

Within the limits of this claim are about twenty mineral springs having temperatures from 50° to 90° F. A sample of one of the springs was sent to G. A. Mariner, of Chicago, for analysis, who reported as follows:

Analysis of water from secs. 29 and 32, T. 15 N., R. 8 E.

[Analyst: G. A. Mariner.]

	Grams.
Silica	0.080410
Calcium carbonate	1.077200
Magnesium carbonate	.617780
Iron oxide	.060500
Sodium sulphate	.090251
Sodium chloride	1.463600
Potassium chloride	Trace.
Sodium carbonate	.063195
Sodium silicate	.062326
Hydrogen sulphide	Trace.
Total solids in one liter	3.515262

These springs are steady in their flow and have shown no signs of failing.

On the north side of Summit Creek in the Cowlitz watershed is a mineral spring claimed by David Longmire. It was located September 5, 1897, as a red mineral paint spring claim. The spring is 4 feet in diameter and is 100 feet from Summit Creek. The amount of flow is about 1 cubic foot per minute. It tastes like soda water strongly impregnated with iron. The temperature is about 40° and the water is very refreshing. The pack animals drank it with relish.

A similar spring is reported on the right bank of Bumping River, 5 miles below Tannum Lake.

A mineral spring is located on the north side of Cowlitz River in sec. 32, T. 13 N., R. 9 E. The waters issue from several fissures of the rock in place and flow into the river, which is only 10 feet distant. The spring is below the level of high water, and its waters are strongly impregnated with sulphur and iron, and have a temperature of about 100° F.

In sec. 34, T. 14 N., R. 14 E., on the south side of Tieton River, are mineral springs having a flow of about 0.25 cubic foot per minute. One has a temperature of 105° F. The others are cold.

The Klickitat soda springs in the north half of sec. 23, T. 11 N., R. 12 E., are probably the finest soda springs in the reserve, although they have not so great a flow as the Longmire Springs, nor are they as well situated for use. The main spring issues from a rock crevice on the south side of Klickitat River, below the high-water line. To make the water accessible the stock herders have built a wing dam which exposes the bubbling spring. Its flow is about 1 cubic foot per minute, and is steady. The water is clear and sparkling, with an agreeable taste resembling vichy. It is a strong appetizer, and acts quickly and vigorously upon the kidneys.

On the north side of the river, and just above high-water mark, are two barely perceptible springs, one warm and the other cold. Two other springs issue in the bed of the stream, and can be located by the bubbles of gas which rise to the surface.

In sec. 36, T. 9 N., R. 12 E., is a fine soda spring, which has long been known and used by the Indians. Its waters are clear and cold and carry iron, as is shown by the red formation about it. Its flow is 0.25 cubic foot per minute. Near this spring are three yellow pines (*Pinus ponderosa*) of less than 18 inches diameter, which have been affected by the spring. Their foliage is of a light-brown color, is very scanty, and droops.

Numerous small soda and iron springs are found along the Clearwater Fork of the Klickitat River in the box canyons.

EVIDENCES OF RECENT VOLCANIC ACTIVITY.

On the slopes of Mount Adams are many evidences of recent volcanic activity, and important among these are cinder cones and bombs.

The cinder cones are miniature volcanoes in form. One, situated about 3 miles northeast of the summit of Mount Adams, at an elevation of 7,000 feet, is worthy of special mention. Its height is about 500 feet and the crater at its summit has a diameter of 175 feet and a depth of 75 feet. The cinders which form its mass and the flora growing upon it are unique and interesting.

The lava, scoria, and pumice are often of brilliant colors—red, orange, and yellow predominating. Some of the pumice is of finer texture than that in use commercially, and the volcanic glass is found in all shades, from black to clear, transparent globules.

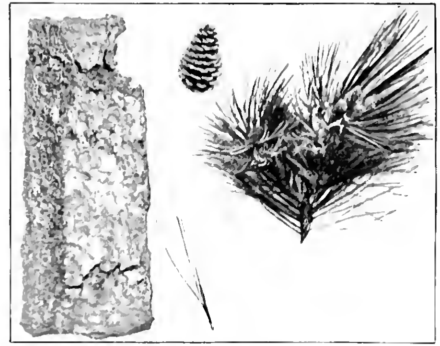
On the northern side of Goat Peak an area of over 1,000 acres is completely covered with scoria and cinders, and this area is timberless. If a crater exists it was covered with snow at the time of the examination.

The bombs found on the lower slopes of Mount Adams are spherical masses of homogenous lava, and lie in piles upon the former lava flows. They are of all sizes up to 20 feet in diameter, and in every case have been fractured and their hard, glassy formation exposed. Frequently the fracture planes show a rind of several inches depth from the original spherical surface toward the center.

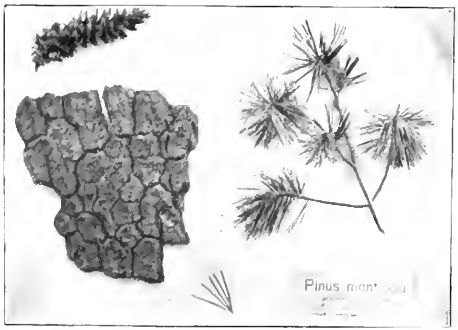
CAVES.

At the headwaters of the White Salmon and Little White Salmon rivers are large areas of partly exposed lava beds. Where a soil has formed it appears to be good, but of no depth, and the timber which it

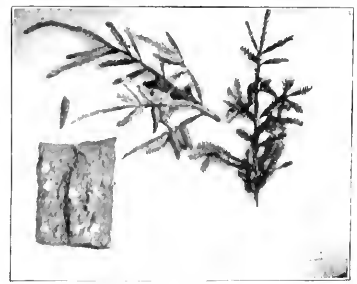
A. TSUGA PATTONIANA.



B. PINUS PONDEROSA.



C. PINUS MONTICOLA



D. PSEUDOTSUGA TAXIFOLIA

supports is scrubby and of small size. A line of caves may be traced along this formation for a distance of 10 miles inside of the reserve and as far again outside. In some cases the caverns appear to exist by reason of the sinking of the flooring, which is of basalt, but quite as frequently they take the form of gigantic bubbles, the roof stratum being buckled up and broken, permitting an entrance to the interior.

Often these caverns are continuous for a considerable distance underground, the passages widening in the vicinity of the surface opening. In one of these caves, situated in sec. 25, T. 6 N., R. 9 E., ice remains during the entire year, and it has merited the local name of the "Ice Cave." It is about 350 feet in length, with a maximum height of 10 feet and extreme width of 60 feet.

The ice is in the form of stalactites and stalagmites; in some cases joined into pillars 3 feet thick. It has been a custom of visitors to build fires in the caves, and much of the natural beauty of this cave has been destroyed. The practice of wantonly breaking the ice formations has also contributed to the destruction of its beauty.

A small cave was found on the southeast slope of Mount Adams, near Hell Roaring River. Deep water prevented its exploration.

MOUNTAIN PARKS.

All the divides become beautiful parks as they approach the slopes of Mount Rainier. In place of the close stand of forest which characterizes the lower slopes, the mountain firs and hemlocks are grouped upon the lesser ridges and hummocks from which the snow first disappears in the spring. At least 80 per cent of the areas above 5,000 feet and below the timber line may be classed as mountain meadows. They are plentifully watered by little streams and lakes and the soil supports a heavy growth of wild flowers, ferns, and juniper. The limit of perpetual snow extending through some of these parks gives opportunities for coasting and snowballing, which are enjoyed by the many campers who make these grounds their summer resort. Parks which are well known because of their beauty and accessibility are Paradise Park, Magnetic Park, and Indian Henry's Ground, on the southern slope of the mountain, Spray Park on the northwest slope, Moraine Park and the Elysian Fields on the northern slope.

The summit of the Cascade Mountains and the high spurs that extend from it are generally a succession of parks, plentifully grassed and flowered. On the eastern slope these areas have been considerably used for pasturing sheep, and much of their natural beauty destroyed, but only in the regions of the burns do any of the grander vistas bear witness to the carelessness or greed of man.

TREE SPECIES.

The coniferous trees of the reserve are as follows:

Coniferous trees of Mount Rainier Forest Reserve, Washington.

Pinus monticola Dougl	White pine.
Pinus ponderosa Laws	Yellow pine.
Pinus murrayana Oreg. Com	Lodgepole pine.
Pinus albicaulis Engelm	Mountain pine (white-bark).
Abies nobilis Lindl	Noble fir (larch).
Abies amabilis (Loud.) Forb	Lovely fir (larch).
Abies concolor (Gord.) Parry	White fir.
Abies lasiocarpa (Hook.) Nutt	Alpine fir (subalpina).
Tsuga mertensiana (Bong.) Carr	Hemlock.
Tsuga pattoniana Engelm	Mountain hemlock.
Picea engelmanni (Jeffr.) Engelm	Engelmann spruce.
Picea sitchensis (Bong) T. and M	Tideland spruce.
Pseudotsuga taxifolia Poir	Red and yellow fir (hemlock spruce).
Thuja plicata Don	Red cedar.
Chamaecyparis nootkatensis (Lamb.) Spach.	Alaska cedar.
Larix occidentalis Nutt	Tamarack.
Taxus brevifolia Nutt	Yew.

The large deciduous trees are as follows:

Deciduous trees of the Mount Rainier Forest Reserve, Washington.

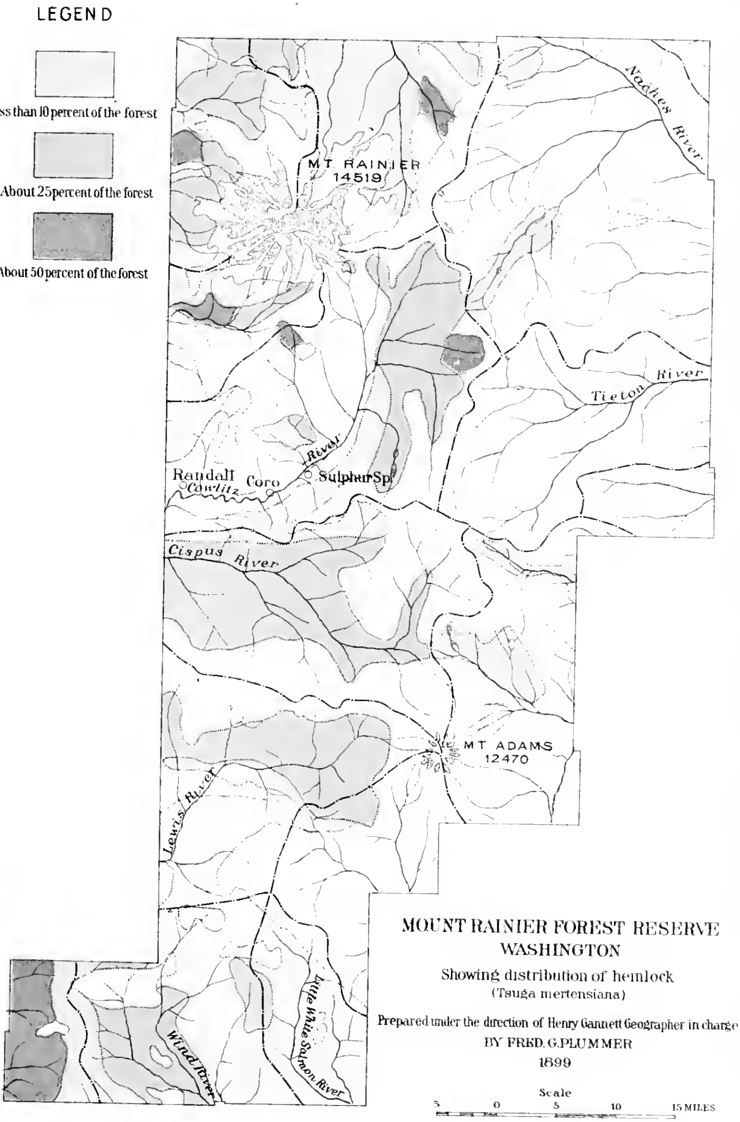
Fraxinus oregona Nutt	Ash.
Acer macrophyllum Pursh	Maple.
Populus trichocarpa Torr. and Gr	Cottonwood.
Populus tremuloides Michx	Quaking aspen.
Quercus garryana Dougl	Oak.

Small deciduous trees of no value as timber are included in the list of underbrush.

In the descriptions which follow, the order of arrangement is the same as given above, the trees of each genus being together without regard to commercial rank.

Pinus monticola Dougl. (White pine).

This species is found from sea level to an elevation of 6,000 feet. The greatest diameter is 5 feet and the extreme height of individuals observed was 150 feet. About two-thirds of the height is crown. The heartwood is white and the sapwood light yellow. The wood is light, soft, not very strong, but quite durable. It reaches its greatest development at an elevation of 3,500 feet, and in comparison with the other pines occupies a middle zone, being above the yellow pine (*P. ponderosa*) and below the lodgepole and mountain pines (*P. murrayana* and *P. albicaulis*). Although not as strong as the yellow pine, the



MOUNT RAINIER FOREST RESERVE
WASHINGTON

Showing distribution of hemlock
(Tsuga mertensiana)

Prepared under the direction of Henry Gannett Geographer in charge
BY FRED. G. PLUMMER
1899

JULIUS BIEN & CO. LITH. N.Y.

absence of pitch and more even texture makes it the most valuable of the pines found in the State of Washington. The typical tree is erect and graceful, with lighter and more delicate foliage than other pines. It is found on both sides of the Cascade Range, but attains its best development on the moist hillsides and benches of the eastern slopes. It does not form a forest of pure growth, being always associated with one or more species of fir or with the red cedar (*Thuja plicata*).

Pinus ponderosa Laws. (Yellow pine).

This species has a range of from 400 to 6,200 feet in altitude. The extreme diameter noted was 6 feet, with a height of 200 feet. The heartwood is yellow and the sapwood is white and resinous. The wood is heavier than that of the white pine and stronger, though rather brittle and not very durable when exposed to moisture. Among the pines it occupies the lowest altitudinal zone, reaching its maximum development at an elevation of 2,500 feet, and by reason of its greater accessibility and distribution it is commercially the first in use. The inferior trees are called bull pines, and with many lumbermen a distinction is made, dependent upon the amount of sapwood in the log.

The yellow pine forms an open forest of pure growth at the lower timber line in eastern Washington bordering the arid region, for the reason that it leads the other conifers in the spreading of the timber. Its ability to grow on worthless rocky soil, on the face of cliffs, or on the talus is marvelous. It is a necessary agent to promote the accumulation of soil and humus for the conifers of greater commercial value which follow its lead.

The yellow pine is not strictly an eastern Washington tree, as it occupies many small and scattered areas on the western prairies near Roy, but these areas are insignificant in comparison with its universal occurrence in the lower timbered areas east of the mountains.

At its highest altitudinal limit the yellow pine, although dwarfed in height, attains large diameter of trunk and appears strong and thrifty. The crown is low and the main branches abnormally heavy and without the symmetry of the typical forest tree at lower altitudes.

Pinus murrayana Oreg. Com. (Lodgepole pine).

The extreme range of this species is from 1,800 to 7,100 feet in altitude, but its growth above 5,000 feet is very scattered, and it is only the presence of a few individuals that puts the upper limit at 7,100 feet. It attains a height of 80 feet and a diameter of 26 inches rarely. The heartwood is creamy, white, or pink, and the sapwood slightly whiter. The timber being generally small and of poor quality, it is chiefly used for fence rails and firewood. At an altitude of 4,000 feet it attains its maximum growth, and on some of the dry river benches forms pure forests over small areas. Even at maturity the crown covers three-fourths or seven-eighths of the height. *Pinus contorta*, also called "black pine," has a lower range to sea level, but was not positively determined within the boundaries of the reserve.

PINUS ALBICAULIS Engelm. (Mountain pine).

This species of pine is only found on the higher elevations, and has a range from 5,000 to 8,200 feet. It is the only tree found above 7,500 feet. Its extreme height is 50 feet, with a diameter of 26 inches. According to its exposure, it may be three-fourths crown or with only a very scanty foliage on the lee side near the top. The heartwood and sapwood are light straw color. The wood is hard and tough, and splits with difficulty.

It sets cones in abundance at an altitude of 7,000 feet, where it often comprises 90 per cent of the trees. Its associates at this altitude are *Abies lasiocarpa*, *Tsuga pattoniana*, and *Chamæcyparis nootkatensis*, all of which have reached their growth at lower elevations. The seeds are edible, and the trees are sometimes cut down to secure them. On one ridge of Mount Adams about 100 trees were felled for this purpose.

At and near its higher altitudinal limit it is a mere shrub, finding shelter behind larger rocks or crags. The foliage is often thickly matted, and in its procumbent form hides the gnarled trunk, which is of monstrous size in comparison with its crown.

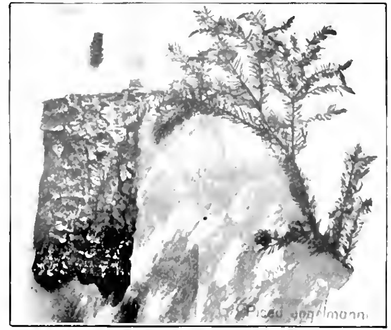
ABIES NOBILIS Lindl. (Noble fir).

This is the finest timber tree in the forests of the reserve, and is found between altitudes of 1,800 and 5,200 feet. The diameter of the largest individual found was 6 feet, with a height of 225 feet. In the forest the crown extends only one-third of the height, and the trunk is generally a perfect cylinder, standing perpendicular. The heartwood and sapwood are light straw color, light, hard, strong, and elastic, and quite free of resin. The elevation at which it flourishes best is 3,000 feet, but with the lovely fir (*Abies amabilis*) it often forms dense forests at 3,500 and even 4,000 feet.

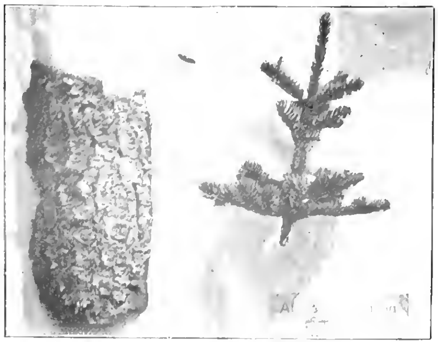
ABIES AMABILIS (Loud.) Forb. (Lovely fir).

This species is found between altitudes of 800 and 5,500 feet. The trees attain a height of 200 feet, with a diameter of 5 feet, of which one-third to one-half is crown in the forest growth. In the open it often has branches to the ground. The heartwood and sapwood are light straw color, the heartwood being slightly darker. The wood is not hard nor very strong, and splits easily between knots.

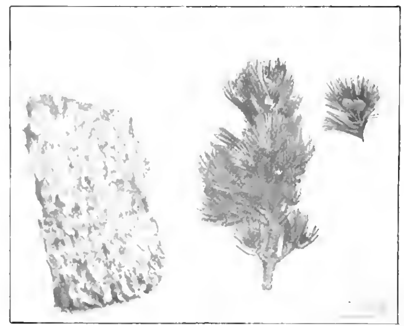
A. LARIX OCCIDENTALIS.



B. PICEA ENGELMANNI.



C. ABIES LASIOCARPA



D. PINUS ALBICAULIS

The wood of this fir is very little known commercially in Washington, but has been cut and sold with the noble fir under the name of larch. Its wood is better than that of the white fir (*Abies concolor*), with which the tree is sometimes confounded, but will not rank with that of the noble fir. It has been used in the manufacture of excelsior.

Abies concolor (Gord.) Parry (White fir).

This fir has an altitudinal range from sea level to 4,200 feet. The extreme diameter noted was 3.5 feet, with a height of 150 feet, of which two-thirds was crown. The heartwood is white and the sapwood a creamy color. The timber is not heavy, hard, nor strong, but is rather brittle, and perishable when exposed to alternate moisture and dryness. There is a prejudice against the wood, as it compares poorly with the species now being logged for building timber. It has been used for inside finishing, and from the larger trees fine shingles can be made.

Abies lasiocarpa (Hook.) Nutt. (Alpine fir).

This beautiful fir has an altitudinal range from 4,000 to 7,500 feet. The greatest diameter is 2 feet and height 80 feet, of which nine-tenths is crown. Heartwood is a creamy color and the sapwood is white. The wood is not very heavy, hard, nor strong, but is elastic and durable when seasoned. It is almost always associated with Patton's hemlock in the higher altitudes. The typical tree is an acute cone extending almost to the ground in strong and vigorous branches. The base of the cone is about one-fifth of the height. The trunk is generally straight, and, by observation of the young trees, is generally scrubby, knotted, and twisted, and much dwarfed in growth. At the timber limit of 7,500 feet it is procumbent and attains the form of grotesque bushes and shrubs. In the lower valleys where this species is found there is sometimes 30 feet of clear trunk, above which the branches droop in graceful curves. The wood splits straight, but with difficulty between the knots, which run to the center of the tree.

This tree is not known to the local lumbermen, and owing to its small size and lack of clear trunk is of little or no commercial value.

Tsuga mertensiana (Bong.) Carr. (Hemlock).

This tree is found from sea level to an altitude of 5,000 feet. Extreme diameter is 6 feet, with a height of 250 feet, of which one-half to two-thirds is crown. The heartwood is grayish white, and the sapwood is cream color. It is not very heavy, but is hard and quite strong. It is more brittle than fir, although not so durable, and the knots run to the center of the tree.

It sometimes forms a forest of pure growth, but in this case the timber is generally very tall and slender, and only suitable for piles. Although in Washington it ranks next to fir in quantity, it is generally considered an inferior wood, and has been logged very little in this State, except in localities where the fir has become scarce. Time will probably overcome the prejudice to the hemlock timber, as it makes very good floors and ceilings and has a very good surface under the plane. It does not splinter like the eastern hemlock, and takes stain and oil easily. The bark of this hemlock is useful for tanning, and the preparation of tanning extract is an industry at Clallam Bay and South Bend. The bark, being very rich in tannic acid, makes a very superior extract. Owing to the limited market on the Pacific coast and the cost of sending the product East to compete with other extracts in a falling market, incident to the panic of 1893, it was found that it could not be manufactured at a profit at South Bend.

TSUGA PATTONIANA Engelm. (Mountain hemlock).

This hemlock is found from an altitude of 3,500 to 7,500 feet. The largest diameter is 3 feet, and height 125 feet, four-fifths of which is crown. The wood is yellow, hard, and somewhat brittle. It sometimes forms a forest of pure growth over limited areas, but is generally found associated with *A. lasiocarpa* and *P. albicaulis*. The largest and heaviest stands of these hemlocks were found at an elevation of 6,000 feet near Jennies Peak, but the clear trunks were seldom over 40 feet.

PICEA ENGELMANNI Engelm. (Engelmann spruce).

This spruce has an altitudinal range from 1,000 to 6,200 feet. The greatest diameter is 3.5 feet, with a height of 150 feet, of which one-half to two-thirds is crown in the forest trees. Mature trees growing in the open generally have a symmetrical cone-shaped crown to the base. The heartwood and sapwood are white, soft, light, and not very strong. It has even grain and splits easily and, being without pitch or disagreeable odor, is a very valuable wood commercially, particularly for cooperage and fruit boxing.

No forest of pure growth was found. The best growth is upon the lower mountain slopes and benches, where it is associated with pines, firs, and tamarack.

PICEA SITCHENSIS (Bong.) T. and M. (Tide-land spruce).

This species is found from sea level up to an elevation of 1,800 feet within the boundaries of the reserve, west of the Cascade Mountains. It sometimes reaches a diameter of 5 feet and a height of 175 feet, of which two-thirds would be crown. The wood is white, light, medium

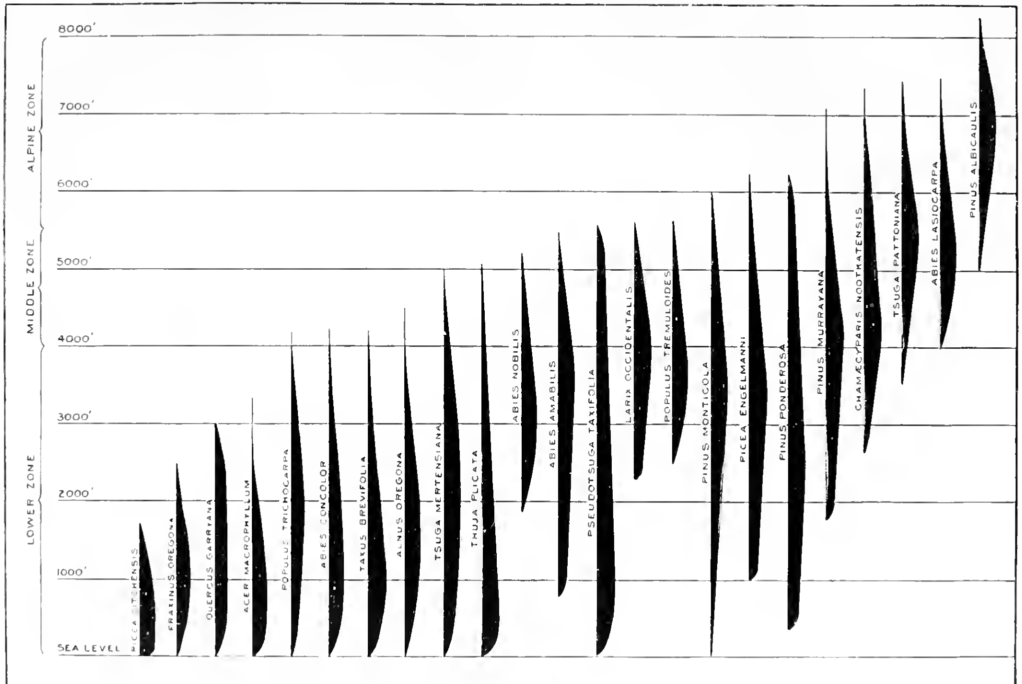


DIAGRAM SHOWING RANGE AND DEVELOPMENT OF TIMBER TREE SPECIES

hard, and strong, and is brittle when green, but quite durable and splits easily. This spruce was positively determined only at one point in the reserve—namely, in the Nisqually Valley, near the west boundary—and it was from this that the upper limit of 1,800 feet was fixed. As its name indicates, its habitat is at lower elevations than those of the reserve.

PSEUDOTSUGA TAXIFOLIA Poir. (Yellow and red fir).

There are two varieties of this species which are not distinct botanically, although the difference is recognized by loggers and mill men throughout the State. The yellow fir grows from sea level to an altitude of 5,600 feet, and reaches an extreme diameter of 13 feet and a height of 300 feet, of which two-thirds is crown. The bark is very thick and deeply fissured. The thickest specimen of bark found measured 22 inches on the radial line. The heartwood is yellow and the sapwood is white, quite heavy, hard, elastic, durable, and splits easily. The red fir, which grows to about the same altitude, does not exceed 7 feet in diameter and 225 feet in height, of which two-thirds is crown. The heartwood is salmon-red color and the sapwood is white or cream color. It is slightly heavier than the yellow fir, more resinous, and not so strong or elastic. When seen in the forest the red fir differs by having a thin bark of a lighter color, and in general does not present as rugged an appearance as the yellow fir. However, many specimens were found which were difficult to determine, and in individual trees it would not be easy to tell the difference between a thin-barked yellow fir and a heavy-barked red fir. Many of the larger trees having a diameter of from 6 to 9 feet are in process of decay, being from 500 to 800 years old. The bark is scaly and loose from the trunk at the butt, and the tops are dead. In estimating the amount of timber per acre a due allowance was made for the above fact. This timber ranks first in commercial value among the timbers of this State by reason of its superior strength, wide distribution, and accessibility.

In the Cowlitz Bottom a fallen fir tree was examined and found to be perfectly sound (excepting 2 inches of the exposed surface), although it had laid upon the ground for seventy-eight years, as testified by the age of a cedar tree which had grown over and straddled it.

THUJA PLICATA Don. (Red cedar).

This tree, which is also known as arbor vitæ, has a range from sea level to 5,100 feet. The extreme diameter breast high was found to be 12 feet with a height of 175 feet, of which three-fifths is crown. The heartwood is very light brown and the sapwood generally white. It is very light, soft, and is not strong nor elastic. It is very durable when exposed to moisture and is generally of straight grain, splitting readily into shingles, shakes, and boards. It ranks next to the red and yellow fir commercially, and to the pioneer settlers in the valley it is the most valuable timber.

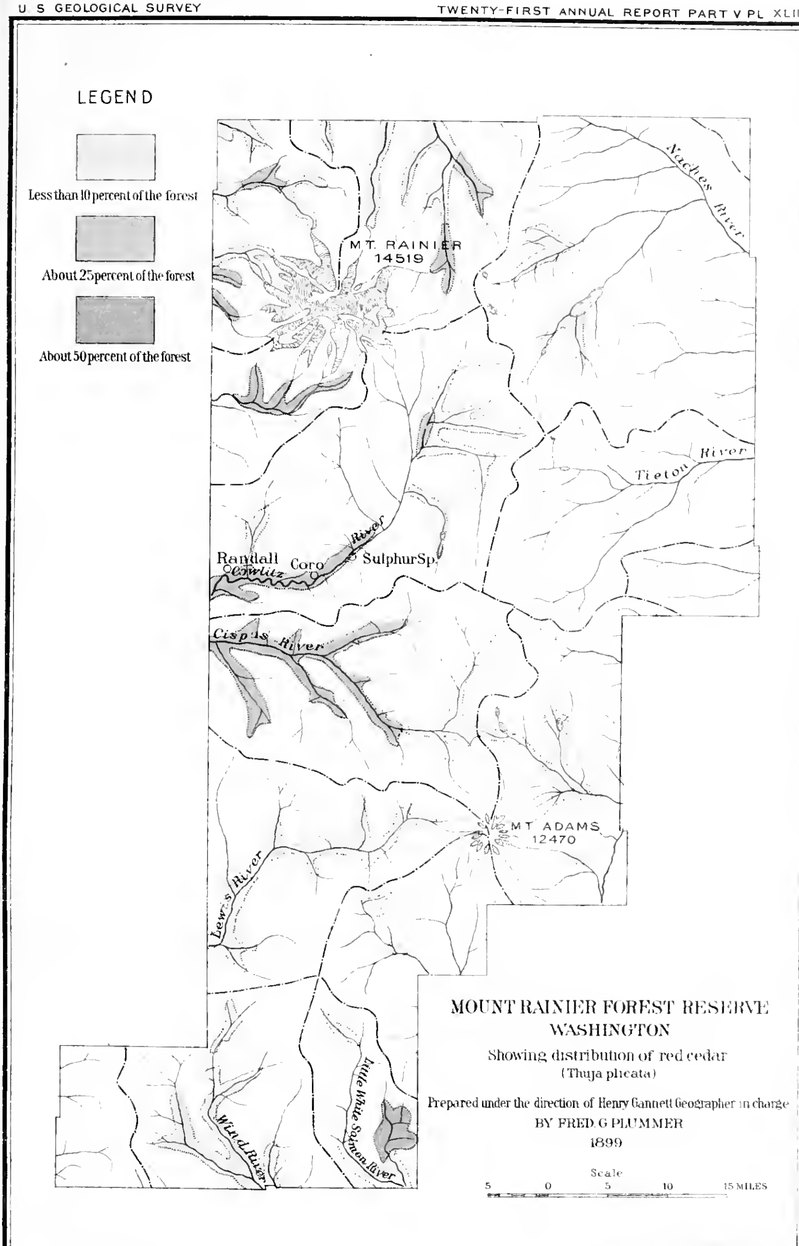
At least 95 per cent of the larger cedars are hollow butted. They always have a swell butt. Of three hollow-butted cedars of 9 feet in diameter the rate of growth, as shown by the shell of sound wood, averaged about ten years per inch radius. In several exceptional cases noted the rate of growth has been very rapid, as much as one-half inch per year for twenty years of successive growth. A fallen cedar tree 36 inches in diameter was observed to be perfectly sound, although another cedar tree 40 inches in diameter had grown over and straddled it. In swamps and swales it sometimes grows to the exclusion of other conifers, but it does not strictly form a forest of pure growth, being accompanied by alders and maples.

CHAMÆCYPARIS NOOTKATENSIS (Lamb.) Spach (Alaska cedar).

This tree is found between elevations of 2,600 and 7,400 feet. The extreme diameter is 3 feet and the height is 100 feet, of which three-fifths is crown. The wood from heart to the bark is yellow. It is light, not very hard nor strong, but is more elastic than the red cedar and very durable, but does not split as easily. Generally the branches look scrubby and give the tree a poor appearance. The outer bark is in long, thin scales and the inner bark strips easily. It never forms a forest of pure growth, but is generally associated with the mountain fir, pine, and hemlock. Generally the areas on which this cedar grows have well-defined limits, but the tree seems to require certain conditions of soil and climate, preferring shady valleys and basins. This timber would be very valuable if more widely distributed and more accessible For turnings and fine woodwork it would excel, as its grain is even and straight, and its color uniform. It would be better material for lead pencils than many varieties of wood now used.

LARIX OCCIDENTALIS Nutt. (Tamarack).

This tree is found between altitudes of 2,200 and 5,600 feet. Extreme diameter is 4½ feet and height 150 feet, of which one-half is crown. The heartwood has an orange tinge and the sapwood is white. It is heavy and hard, not very strong, but is durable and does not split easily. It sometimes forms a forest of pure growth on the sides of the river canyons, and such a forest was found upon the flat divide between the Naches and American rivers. The wood makes good tie timber, and is largely used for fuel in eastern Washington. Probably this is the only timber tree of Washington which is not represented on both sides of the Cascade Mountains. It is strictly an eastern-slope tree, and is the only representative of the deciduous conifers in the reserve.


LEGEND
Less than 10 percent of the forest
About 25 percent of the forest
About 50 percent of the forest
MT. RAINIER
14519
Naches River
Tieton River
Randall
Cowlitz
Coro
River
Sulphur Sp.
Cispus River
MT ADAMS
12470
Lewis River
Wind River
Little White Salmon River
MOUNT RAINIER FOREST RESERVE
WASHINGTON
Showing distribution of red cedar
(Thuja plicata)
Prepared under the direction of Henry Gannett Geographer in charge
BY FRED. G PLUMMER
1899
Scale
5 0 5 10 15 MILES

TAXUS BREVIFOLIA Nutt. (Yew).

This species of yew is found from sea level to an altitude of 4,200 feet. Generally the diameter of the mature tree is about 12 inches, but a few individuals were found with a diameter of 2 feet and a height of 40 feet, of which three-fifths is crown. The heartwood is a deep red and the sapwood has a narrow zone of cream-colored wood. It is very heavy, hard, and strong. It is exceptionally tough and durable when not exposed to extremes of moisture and dryness, and will not split after being seasoned. Although absolutely sound on the outside, one tree 14 inches in diameter was found to be badly split on concentric lines from the butt to a height of 25 feet.

FRAXINUS OREGONA Nutt. (Ash).

This tree has a range from sea level outside of the reserve to an elevation of 2,500 feet within the reserve. Its diameter is 3 feet and height 80 feet, of which two-thirds is crown. The wood is white, heavy, hard, but not very strong as compared with the eastern ash. It is springy and quite durable when seasoned. It splits easily and is used for firewood by the settlers. The only large quantity was found in the "Big Bottom" of Cowlitz Valley, where it is associated with maples and alders.

ACER MACROPHYLLUM Pursh. (Maple).

This maple is found from sea level to an elevation of 3,300 feet. The extreme diameter is 5 feet with a height of 30 feet, three-fourths to seven-eighths of which is crown. The heartwood is straw color and the sapwood is white. It is not heavy, but is quite hard, although the tree is locally known as the soft maple. The wood is strong. It forms small groves of pure growth in the Cowlitz Bottom, but is generally associated with the ash, yew, and alder.

POPULUS TRICHOCARPA Torr. and Gr. (Cottonwood).

This tree grows from sea level to an elevation of 4,200 feet. The greatest diameter is 5 feet and the height 175 feet, of which two-thirds is crown. The heartwood is of a buff color and the sapwood is white. It is light, and is not hard or strong; in fact, it has no quality to recommend it commercially as a timber wood, but has been extensively used in the manufacture of paper pulp.

POPULUS TREMULOIDES Michx. (Quaking aspen).

This tree is found in the wet swales and bottoms, and has an altitudinal range from 2,500 to 5,800 feet. It does not exceed 20 inches in diameter, with a height of 60 feet, of which one-half is crown. The wood is white and soft and of little or no value commercially. All of the large trees examined were rotten at the butt, although they looked clean and healthy outside.

Quercus garryana Dougl. (Oak).

This oak is the only one of its species found in the reserve, and, unless the ash and yew be included, it is the only hardwood tree represented. Generally the trees are small, with short trunks, and offer nothing to the lumbermen, but a few individuals were noted with diameters of 2 feet and a height of 50 feet. They are seen at their best on the eastern slope in the watershed of the Klickitat River near Hell Roaring Canyon. This oak is considered first-class fuel, and has been cut extensively along the Columbia River (outside the reserve) for this purpose.

RANGE OF TREE SPECIES.

The accompanying diagram (Pl. XLI) shows in a graphic way the altitudinal range of the species of timber trees found in the reserve. The datum is given as sea level, and those species which extend outside the reserve to tide water are so shown upon the diagram.

The lines showing each species have been widened into forms which are intended to show by their width the relative development of the species. This diagram was compiled from observations taken at 521 locations, ranging in altitude from 700 to 8,200 feet.

The name of each species is placed in the zone to which the tree belongs.

RATE OF GROWTH OF TIMBER TREES.

The average rate of growth of all the conifers, as determined by measuring over 8,000 annual rings, is 0.0741 of an inch per year.

In the table which follows the number of annual rings is given for each 3 inches of radius, and therefore show an increase or decrease in the rate of growth. For example, *Pinus murrayana*, according to the table, shows an increase in the number of rings for each 3 inches of radius. Therefore the rings are closer together near the bark than at the heart, and the rate of growth decreases with age.

When the diameter of a tree was over 36 inches, the measurements are continued in regular order on the lines below, as in the case of *Pseudotsuga taxifolia*.

Table showing rate of growth of timber trees.

Name of tree.	Diameter of wood.	Thickness of bark.	Total diameter.	Number of rings counted on radius from the center. 1-3 inches.	4-6 inches.	7-9 inches.	10-12 inches.	13-15 inches.	16-18 inches.	Age of tree.
	In.	*In.*	*In.*							*Years*
Pinus monticola	7	¼	7½	36	11	....	....	....	....	47
Do	22	¾	23½	15	13	17	12	....	....	57
Do	16	½	17	19	19	17	....	....	....	55
Pinus ponderosa	25	2	29	29	36	43	39	7	....	154
Do	31½	2½	36½	27	33	28	38	52	15	193
Do	22	2	26	41	41	61	59	....	....	202
Pinus murrayana	19	¼	19½	34	38	82	39	....	....	193
Do	14	¼	14¼	45	50	62	....	....	....	157
Do	19	¼	19½	26	31	45	5	....	....	107
Do	18	¼	18½	18	28	54	....	....	....	100
Pinus albicaulis	9	¼	9½	130	55	....	....	....	....	185
Do	13	½	14	133	99	35	....	....	....	267
Do	14	½	15	85	115	45	....	....	....	245
Do	20½	¼	21	42	44	59	46	....	....	191
Do	9½	½	10	48	33	....	....	....	....	81
Abies nobilis	22	⅜	22¾	27	15	14	9	....	....	65
Do	17	¼	17½	37	18	12	....	....	....	67
Do	31	1	33	56	36	28	24	24	6	174
Abies amabilis	20	¼	20½	16	20	13	6	....	....	55
Do	12	½	13	71	25	....	....	....	....	96
Do	11	⅜	11¾	68	73	....	....	....	....	141
Do	20	⅜	20¾	132	88	55	13	....	....	288
Do	10	¼	10½	40	28	....	....	....	....	68
Do	15½	¼	16	71	51	50	....	....	....	172
Abies concolor	20	1	22	40	60	96	38	....	....	234
Do	12	¾	13½	74	105	....	....	....	....	179
Do	20	¾	21½	52	37	53	27	....	....	169
Do	17	1	19	64	67	83	....	....	....	214
Do	11	⅜	11¾	119	98	....	....	....	....	217
Abies lasiocarpa	14	¾	15½	60	50	10	....	....	....	120
Do	15	¾	16½	60	48	17	....	....	....	125
Do	10	½	11	40	41	....	....	....	....	81
Do	19	½	20	38	43	70	....	....	....	151
Do	10	¼	10½	34	14	....	....	....	....	48
Tsuga mertensiana	31	1	33	64	70	65	63	84	12	358
Do	29	¾	30½	30	24	25	36	41	....	156

Table showing rate of growth of timber trees—Continued.

Name of tree.	Diameter of wood.	Thickness of bark.	Total diameter.	Number of rings counted on radius from the center. 1–3 inches.	4–6 inches.	7–9 inches.	10–12 inches.	13–15 inches.	16–18 inches.	Age of tree.
	In.	*In.*	*In.*							*Years.*
Tsuga pattoniana	14½	1½	17½	54	62	60				176
Do	13	1¼	15½	58	78	12				148
Picea engelmanni	13½	¼	14	65	23	4				92
Do	29	¾	30½	30	16	16	20	24		106
Do	20	1	22	30	40	43	28			141
Pseudotsuga taxifolia	72	6	84	39	40	40	41	41	41	
Do				40	40	41	41	40	40	484
Do	120	18	156	9	11	16	14	15	25	
Do				31	19	18	21	18	15	
Do				18	15	20	21	25	28	
Do				32	37					408
Do	30	¾	31½	38	32	12	9	17		108
Do	30	¾	31½	73	14	10	11	10		118
Do	40	4	48	15	15	22	35	46	68	
Do				41						242
Do	38	3	44	11	18	30	38	46	56	
Do				19						216
Do	38	2½	43	17	47	34	50	64	110	
Do				40						362
Do	31	2	35	58	54	62	88	98	28	388
Thuja plicata	52	1	54	48	18	16	14	13	17	
Do				20	22	14				182
Do	34	¼	34½	26	27	10	10	14	10	97
Do	40	¼	40½	27	21	21	6	8	15	
Do				15						113
Do	18	1	20	25	35	42	46	56	50	254
Chamaecyparis nootkatensis	19½	¼	20	78	74	97	23			272
Do	19	¼	19½	48	60	112	10			230
Do	28½	½	29½	(*a*)						380?
Do	22	½	23	60	74	90	59			283
Larix occidentalis	19	2	23	15	14	32	9			70
Fraxinus oregona	24	¾	25½	25	25	42	50			142
Do	26½	¾	28	25	25	29	44	25		148
Do	5	¼	5½	34						34
Do	10½	⅜	11¼	38	23					61

a Rings too close to count accurately.

Table showing rate of growth of timber trees—Continued.

Name of tree.	Diameter of wood.	Thickness of bark.	Total diameter.	Number of rings counted on radius from the center.						Age of tree.
				1–3 inches.	4–6 inches.	7–9 inches.	10–12 inches.	13–15 inches.	16–18 inches.	
	In.	*In.*	*In.*							*Years.*
Acer macrophyllum	11	½	12	68	35	....	....	....	....	103
Do	28	1	30	48	23	26	38	23	....	158
Do	6	¼	6½	62	....	....	....	....	....	62
Populus trichocarpa	8	½	9	33	10	....	....	....	....	43
Do	23	1¼	25½	20	21	17	26	....	....	84
Populus tremuloides	14	½	15	24	21	8	....	....	....	53
Do	18	¾	19½	30	26	30	....	....	....	86
Taxus brevifolia	4	⅛	4¼	53	....	....	....	....	....	53
Do	5	⅛	5¼	68	....	....	....	....	....	68
Do	16	⅛	16¼	63	53	63	....	....	....	179
Do	10	⅛	10¼	77	81	....	....	....	....	158
Alnus oregona	9½	¼	10	36	23	....	....	....	....	59
Pyrus rivularis	4	⅛	4¼	48	....	....	....	....	....	48
Rhamnus purshiana	6	⅛	6¼	60	....	....	....	....	....	60
Do	5½	⅛	5¾	44	....	....	....	....	....	44
Acer circinatum	4	⅛	4¼	50	....	....	....	....	....	50
Do	7	⅛	7¼	41	7	....	....	....	....	48
Salix lasiandra	4	¼	4½	18	....	....	....	....	....	18
Cornus nuttallii	4	⅛	4¼	32	....	....	....	....	....	32

DEFECTS AND DISEASES OF TIMBER TREES.

About 5 per cent of the forest stand within the reserve is composed of dead snags scattered through the green and live growth. This condition is common to all forests, as it results from the fact that trees die. The cause, however, is not only that of final maturity, for the great majority of these standing snags were young or middle-aged trees, many of which died from lack of light and air—killed by their more vigorous neighbors.

Individual cases were noted where camp fires had run up and killed single trees, also where lightning had struck and killed trees without the fire spreading. Not uncommonly a heavy fall of snow will break the upper branches of a tree, and these falling will strip the trunk of all foliage—a setback that only a vigorous and well-situated conifer can survive.

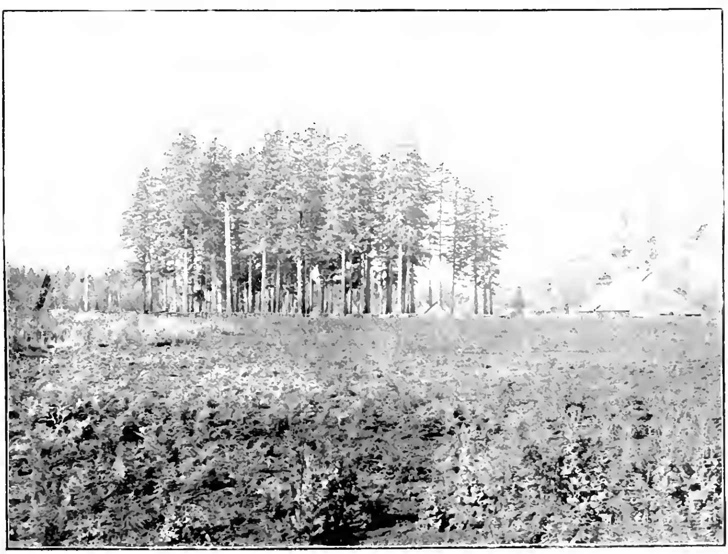
In those areas where the soil is excessively moist, a common defect is the hollow butt or ground rot. In such places the root hold is not good, and the conifers, lacking the taproot, compensate by developing an enormous growth of roots on a plane conforming with the surface of the ground, thus increasing the base area upon which they stand. Such trees have the "swell butts," and it is not unusual to see a tree of which a section made at the surface of the ground would have from five to ten times the area of a parallel section made 15 feet above it. In these swell butts there is no straight-grain lumber and the wood is coarse, resulting from the rapid growth, which in the case of the red cedar (*Thuja plicata*) amounts to as much as one-half inch annually.

In logging, it is customary to cut the trees above the swell butts, leaving on the stump that portion of the trunk with the decayed center, and in the case of the firs to reject the sappy base of the tree. Cedars with decayed butts generally show dead tops, but this is of minor interest to the lumberman, who seldom cuts logs far into the crown.

In the ideal forest of the lumberman the trees have clear trunks to 100 or 125 feet of height and the crowns form a continuous cover as seen either from below or above. Seldom is the seedling in such a forest able to compete under such conditions, for the existence of such a forest means the elimination of perhaps a hundred seedlings before supremacy in the sapling stage had been established, and the final elimination of at least 90 per cent of the saplings before each successful tree grows skyward in the final competition for light. In areas where this severe competition does not obtain, the tree trunks are "limby," and even when the trunks appear clear at first glance the logs contain "pin knots," which, running through the heartwood, render the lumber second or third class. Large trees standing in the open, where the winds have greater effect, generally throw very few limbs toward the prevailing winds, but compensate on the protected side. The growth of the trunk is then eccentric to the heart and the lumber is not even grained. In the higher and more exposed areas the trees are often without limbs on the storm side, generally the southwest side, and the trees are stunted, as described elsewhere in this report.

It can not be said that the giant shelf fungus (*Polyporus* sp.) is a factor in killing or even in hastening the death of the large dead timber upon which it is found. Of the many hundreds of these fungi that were observed, not one was found upon a living tree. The arceuthobium, on the contrary, attacks the living trees, and its range of activity appears not to be limited by altitude. It is a parasite on the foliage of the pines, firs, and hemlocks of eastern Washington, and in some cases, particularly on the mountain fir (*Abies lasiocarpa*), will cover the entire tree and, turning the foliage a red color, makes the tree a conspicuous object.

A. PINES AND RED FIR.



B. RED FIR IN COWLITZ BOTTOM

ESTIMATES OF TIMBER.

WHITE RIVER WATERSHED.

Density of timber in White River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	33,570	33,570,000
2,000 to 5,000	18,600	65,100,000
5,000 to 10,000	16,450	123,375,000
10,000 to 25,000	29,150	510,125,000
25,000 to 50,000	16,000	600,000,000
50,000 to 100,000	20,850	1,563,750,000
Total	134,620	2,895,920,000

Average stand per acre for entire watershed, 18,544 feet B. M.

Area of timbered and other lands in White River watershed, Washington.

	Acres.
Timbered area	134,620
Burned area	10,200
Glaciers	8,900
Timberless area	2,440
Total	156,160

Proportions and amounts of timber species in White River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	45	1,303,164,000
Hemlock	25	723,980,000
Red cedar	15	434,388,000
Engelmann spruce	5	144,796,000
White pine	3	86,877,600
Alaska cedar	2	57,918,400
White fir, Lovely fir, Noble fir, Mountain fir, Mountain hemlock	5	144,796,000
Total	100	2,895,920,000

PUYALLUP RIVER WATERSHED.

Density of timber in Puyallup River watershed, Washington.

Stand in feet B. M. per acre	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	30,160	30,160,000
2,000 to 5,000	26,770	93,695,000
5,000 to 10,000	11,150	83,625,000
10,000 to 25,000	8,500	148,750,000
25,000 to 50,000	10,900	408,750,000
50,000 to 100,000	12,470	935,250,000
Total	99,950	1,700,230,000

Average stand per acre for entire watershed, 14,428 feet B. M.

Area of timbered and other lands in Puyallup watershed, Washington.

	Acres.
Timbered area	99,950
Burned area	2,580
Glaciers	12,600
Timberless area	2,710
Total	117,840

Proportions and amounts of timber species in Puyallup River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir........	50	850,115,000
Hemlock	25	425,057,500
Red cedar	10	170,023,000
Noble fir	5	85,011,500
White fir........	3	51,006,900
Alaska cedar........	2	34,004,600
Lovely fir........		
Engelmann spruce		
Mountain fir........	5	85,011,500
Mountain hemlock		
White pine		
Total........	100	1,700,230,000

NISQUALLY RIVER WATERSHED.

Density of timber in Nisqually River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	16,610	16,610,000
2,000 to 5,000	3,360	11,760,000
5,000 to 10,000	6,770	50,775,000
10,000 to 25,000	5,960	104,300,000
25,000 to 50,000	6,370	238,875,000
50,000 to 100,000	....	....
Total	39,070	422,320,000

Average stand per acre for entire watershed, 5,414 feet B. M.

Area of timbered and other lands in Nisqually River watershed, Washington.

	Acres.
Timbered area	39,070
Burned area	27,810
Glaciers	8,100
Timberless area	3,020
Total	78,000

Proportions and amounts of timber species in Nisqually River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	50	211,160,000
Hemlock	25	105,580,000
Red cedar	10	42,232,000
White fir	5	21,116,000
Noble fir	4	16,892,800
Alaska cedar	1	4,223,200
Lovely fir Engelmann spruce Mountain fir Mountain hemlock White pine	5	21,116,000
Total	100	422,320,000

COWLITZ RIVER WATERSHED.

Density of timber in Cowlitz River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	37,850	37,850,000
2,000 to 5,000	96,380	337,330,000
5,000 to 10,000	12,540	94,050,000
10,000 to 25,000	47,610	833,175,000
25,000 to 50,000	3,720	139,500,000
50,000 to 100,000	2,560	192,000,000
Total	200,660	1,633,905,000

Average stand per acre for entire watershed, 5,611 feet B. M.

Area of timbered and other lands in Cowlitz River watershed, Washington.

	Acres.
Timbered area	200,660
Burned area	86,900
Glaciers	2,900
Timberless area	740
Total	291,200

Proportions and amounts of timber species in Cowlitz River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	55	898,647,750
Hemlock	25	408,476,250
Red cedar	5	81,695,250
White fir	5	81,695,250
Noble fir	4	65,356,200
Alaska cedar	1	16,339,050
Lovely fir Mountain fir Mountain hemlock White pine Engelmann spruce	5	81,695,250
Total	100	1,633,905,000

CISPUS RIVER WATERSHED.

Density of timber in Cispus River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	27,400	27,400,000
2,000 to 5,000	64,200	224,700,000
5,000 to 10,000	24,300	182,250,000
10,000 to 25,000	76,800	1,344,000,000
25,000 to 50,000	----------	----------
50,000 to 100,000	----------	----------
Total	192,700	1,778,350,000

Average stand per acre for entire watershed, 7,535 feet B. M.

Area of timbered and other lands in Cispus River watershed, Washington.

	Acres.
Timbered area	192,700
Burned area	43,000
Glaciers	100
Timberless area	200
Total	236,000

Proportions and amounts of timber species in Cispus River watershed, Washington.

Species.	Proportion	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	45	800,257,500
Hemlock	30	533,505,000
Red cedar	10	177,835,000
Noble fir	5	88,917,500
White fir	5	88,917,500
Lovely fir, Mountain fir, Mountain hemlock, White pine, Alaska cedar	5	88,917,500
Total	100	1,778,350,000

LEWIS RIVER WATERSHED.

Density of timber in Lewis River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	14,730	14,730,000
2,000 to 5,000	48,450	169,575,000
5,000 to 10,000	61,810	463,575,000
10,000 to 25,000	7,900	138,250,000
25,000 to 50,000	54,730	2,052,375,000
50,000 to 100,000	1,620	121,500,000
Total	189,240	2,960,005,000

Average stand per acre for entire watershed, 13,295 feet B. M.

Area of timbered and other lands in Lewis River watershed, Washington.

	Acres.
Timbered area	189,240
Burned area	32,360
Glaciers	350
Timberless area	690
Total	222,640

Proportions and amounts of timber species in Lewis River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	50	1,480,002,500
Hemlock	20	592,001,000
Noble fir	15	444,000,750
Red cedar	5	148,000,250
Lovely fir	5	148,000,250
White fir Mountain fir Mountain hemlock White pine	5	148,000,250
Total	100	2,960,005,000

WASHOUGAL RIVER WATERSHED.

Density of timber in Washougal River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	....	....
2,000 to 5,000	....	....
5,000 to 10,000	2,370	17,775,000
10,000 to 25,000	....	....
25,000 to 50,000	....	....
50,000 to 100,000	910	68,250,000
Total..........	3,280	86,025,000

Average stand per acre for entire watershed, 26,227 feet B. M.
Area of watershed, all timbered, 3,280 acres.

Proportions and amounts of timber species in Washougal River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir........	30	25,807,500
Noble fir	25	21,506,250
Lovely fir	25	21,506,250
Hemlock	15	12,903,750
Red cedar		
White fir................	5	4,301,250
White pine		
Total................	100	86,025,000

ROCK CREEK WATERSHED.

Density of timber in Rock Creek watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	....	....
2,000 to 5,000	....	....
5,000 to 10,000	690	5,175,000
10,000 to 25,000	....	....
25,000 to 50,000	690	25,875,000
50,000 to 100,000	4,660	349,500,000
Total..........	6,040	380,550,000

Average stand per acre for entire watershed, 63,005 feet B. M.
Area of watershed, all timbered, 6,040 acres.

Proportions and amounts of timber species in Rock Creek watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	30	114,165,000
Noble fir	25	95,137,500
Lovely fir	25	95,137,500
Hemlock	15	57,082,500
Red cedar		
White fir	5	19,027,500
White pine		
Total	100	380,550,000

WIND RIVER WATERSHED.

Density of timber in Wind River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	21,810	21,810,000
2,000 to 5,000	7,970	27,895,000
5,000 to 10,000	3,220	24,150,000
10,000 to 25,000	17,700	309,750,000
25,000 to 50,000	52,900	1,983,750,000
50,000 to 100,000	18,430	1,382,250,000
Total	122,030	3,749,605,000

Average stand per acre for entire watershed, 25,858 feet B. M.

Area of timber and other lands in the Wind River watershed, Washington.

	Acres.
Timbered area	122,030
Burned area	22,970
Total	145,000

Proportions and amounts of timber species in Wind River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	45	1,687,322,250
Hemlock	15	562,440,750
Noble fir	10	374,960,500
Lovely fir	10	374,960,500
White fir	5	187,480,250
Red cedar	5	187,480,250
White pine	5	187,480,250
Lodgepole pine Mountain fir Mountain hemlock Engelmann spruce	5	187,480,250
Total	100	3,749,605,000

LITTLE WHITE SALMON RIVER WATERSHED.

Density of timber in Little White Salmon River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	16,080	16,080,000
2,000 to 5,000	39,590	138,565,000
5,000 to 10,000	4,720	35,400,000
10,000 to 25,000	6,430	112,525,000
25,000 to 50,000	....	....
50,000 to 100,000	....	....
Total	66,820	302,570,000

Average stand per acre for entire watershed, 4,223 feet B. M.

Area of timbered and other lands in Little White Salmon River watershed, Washington.

	Acres.
Timbered area	66,820
Burned area	4,830
Total	71,650

Proportions and amounts of timber species in Little White Salmon River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	55	166,413,500
Hemlock	10	30,257,000
Red cedar	10	30,257,000
White pine	5	15,128,500
Yellow pine	5	15,128,500
Engelmann spruce	5	15,128,500
White fir	3	9,077,100
Noble fir	2	6,051,400
Tamarack Lovely fir Mountain fir Mountain hemlock	5	15,128,500
Total	100	302,570,000

WHITE SALMON RIVER WATERSHED.

Density of timber in White Salmon River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	13,370	13,370,000
2,000 to 5,000	23,670	82,845,000
5,000 to 10,000	30,650	229,875,000
10,000 to 25,000	5,990	104,825,000
25,000 to 50,000	2,890	108,375,000
50,000 to 100,000		
Total	76,570	539,290,000

Average stand per acre for entire watershed, 5,106 feet B. M.

Area of timbered and other lands in White Salmon River watershed, Washington.

	Acres.
Timbered area	76,570
Burned area	27,200
Glaciers	450
Timberless area	1,380
Total	105,600

Proportions and amounts of timber species in White Salmon River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Yellow pine	40	215,716,000
Red or yellow fir	30	161,787,000
Tamarack	10	53,929,000
White pine	5	26,964,500
Hemlock	4	21,571,600
Noble fir	3	16,178,700
Red cedar	3	16,178,700
White fir Lovely fir Lodgepole pine Engelmann spruce Mountain fir Mountain hemlock	5	26,964,500
Total	100	539,290,000

KLICKITAT RIVER WATERSHED.

Density of timber in Klickitat River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand
		Feet B. M.
0 to 2,000	29,580	29,580,000
2,000 to 5,000	31,660	110,810,000
5,000 to 10,000	15,070	113,025,000
10,000 to 25,000	35,440	620,200,000
25,000 to 50,000	17,600	660,000,000
50,000 to 100,000	4,460	334,500,000
Total	133,810	1,868,115,000

Average stand per acre for entire watershed, 11,075 feet B. M.

Area of timbered and other lands in Klickitat River watershed, Washington.

	Acres.
Timbered area	133,810
Burned area	30,230
Glaciers	1,400
Timberless area	3,240
Total	168,680

Proportions and amounts of timber species in Klickitat River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Yellow pine	55	1,027,463,250
Red or yellow fir	20	373,623,000
Tamarack	10	186,811,500
White pine	5	93,405,750
Mountain hemlock	5	93,405,750
White fir		
Hemlock		
Engelmann spruce		
Mountain fir		
Lovely fir	5	93,405,750
Red cedar		
Alaska cedar		
Lodgepole pine		
Total	100	1,868,115,000

ATANUM RIVER WATERSHED.

Density of timber in Atanum River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	12,790	12,790,000
2,000 to 5,000	13,240	46,340,000
5,000 to 10,000	....	....
10,000 to 25,000	....	....
25,000 to 50,000	....	....
50,000 to 100,000	....	....
Total	26,030	59,130,000

Average stand per acre for entire watershed, 1,454 feet B. M.

Area of timbered and other lands in Atanum River watershed, Washington.

	Acres.
Timbered area	26,030
Burned area	14,630
Total	40,660

Proportions and amounts of timber species in Atanum River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Yellow pine	60	35,478,000
Red or yellow fir	15	8,869,500
Tamarack	10	5,913,000
Mountain fir	5	2,956,500
Mountain hemlock	3	1,773,900
Lodgepole pine	2	1,182,600
White fir, Lovely fir, Engelmann spruce, White pine, Red cedar, Alaska cedar	5	2,956,500
Total	100	59,130,000

TIETON RIVER WATERSHED.

Density of timber in Tieton River watershed, Washington.

Stand in feet B.M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	45,270	45,270,000
2,000 to 5,000	71,520	250,320,000
5,000 to 10,000	29,970	224,775,000
10,000 to 25,000	4,610	80,675,000
25,000 to 50,000	940	35,250,000
50,000 to 100,000	....	....
Total	152,310	636,290,000

Average stand per acre for entire watershed, 3,765 feet B. M.

Area of timbered and other land in Tieton River watershed, Washington.

	Acres.
Timbered area	152,310
Burned area	16,370
Timberless area	320
Total	169,000

Proportions and amounts of timber species in Tieton River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Yellow pine	50	318,145,000
Red or yellow fir	35	222,701,500
Tamarack	10	63,629,000
Red cedar Engelmann spruce White fir White pine Lodgepole pine Mountain fir Mountain hemlock Alaska cedar	5	31,814,500
Total	100	636,290,000

NACHES RIVER WATERSHED.

Density of timber in Naches River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	108,500	108,500,000
2,000 to 5,000	188,300	659,050,000
5,000 to 10,000	16,000	120,000,000
10,000 to 25,000	5,410	94,675,000
25,000 to 50,000		
50,000 to 100,000		
Total	318,210	982,225,000

Average stand per acre for entire watershed, 3,002 feet B. M.

Area of timbered and other lands in Naches River watershed, Washington.

	Acres.
Timbered area	318,210
Burned area	7,510
Timberless area	1,450
Total	327,170

Proportions and amounts of timber species in Naches River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Yellow pine	45	442,001,250
Red or yellow fir	25	245,556,250
Tamarack	20	196,445,000
Hemlock	5	49,111,250
Red cedar, White pine, Lodgepole pine, Noble fir, Lovely fir, White fir, Mountain fir, Mountain hemlock, Engelmann spruce, Alaska cedar	5	49,111,250
Total	100	982,225,000

YAKIMA RIVER WATERSHED.

Density of timber in Yakima River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	3,250	3,250,000
2,000 to 5,000	4,430	15,505,000
5,000 to 10,000		
10,000 to 25,000		
25,000 to 50,000		
50,000 to 100,000		
Total	7,680	18,755,000

Average stand per acre for entire watershed, 2,442 feet B. M.
Area of watershed, all timbered, 7.680 acres.

Proportions and amounts of timber species in Yakima River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Yellow pine	45	8,439,750
Red or yellow fir	30	5,626,500
Tamarack	10	1,875,500
Engelmann spruce	10	1,875,500
Mountain hemlock; Mountain fir; White fir; White pine; Lodgepole pine; Red cedar	5	937,750
Total	100	18,755,000

SUMMARY OF ESTIMATES.

Total timber estimates, arranged by watersheds.

Watershed.	Area.	Average per acre.	Total.
	Acres.	*Feet B. M.*	*Feet B. M.*
White River	156,160	18,544	2,895,920,000
Puyallup River	117,840	14,428	1,700,230,000
Nisqually River	78,000	5,414	422,320,000
Cowlitz River	291,200	5,611	1,633,905,000
Cispus River	236,000	7,535	1,778,350,000
Lewis River	222,640	13,295	2,960,005,000
Washougal River	3,280	26,227	86,025,000
Rock Creek	6,040	63,005	380,550,000
Wind River	145,000	25,858	3,749,605,000
Little White Salmon River	71,650	4,223	302,570,000
White Salmon River	105,600	5,106	539,290,000
Klickitat River	168,680	11,075	1,868,115,000
Atanum River	40,660	1,454	59,130,000
Tieton River	169,000	3,765	636,290,000
Naches River	327,170	3,002	982,225,000
Yakima River	7,680	2,442	18,755,000
Total	2,146,600	9,323	20,013,285,000

Total timber estimates, arranged by species of trees.

	Feet B. M.		Feet B. M.
Red or yellow fir	8,555,218,750	Tamarack	512,385,000
Hemlock	3,533,642,000	Mountain hemlock	280,677,000
Yellow pine	2,062,371,750	Engelmann spruce	271,785,000
Red cedar	1,317,078,500	Mountain fir	200,130,000
Noble fir	1,247,883,500	Alaska cedar	151,326,000
Lovely fir	749,267,500	Lodgepole pine	73,267,000
White fir	538,735,000		
White pine	519,518,000	Total	20,013,285,000

COMMERCIAL USES OF TIMBERS.

In importance, all things considered, the principal timber trees of the reserve will at this time rank commercially in the following order:

Commercial rank of timber trees in Mount Rainier Reserve, Washington.

Red or yellow fir (Pseudotsuga taxifolia).
Red cedar (Thuja plicata).
Tide-land spruce (Picea sitchensis).
Yellow pine (Pinus ponderosa).
White pine (Pinus monticola).
Noble fir (Abies nobilis).
Lovely fir (Abies amabalis).
White fir (Abies concolor).
Hemlock (Tsuga mertensiana).
Tamarack (Larix occidentalis).

The above order results from size, quantity, and accessibility of the trees and the properties of the various woods.

If arranged in the order of the desirable properties of the woods and ignoring the question of size, quantity, and accessibility, the timbers will take rank as follows:

Rank of timber trees in order of desirable properties.

1. Alaska cedar
2. Noble fir
3. Tideland spruce
4. White pine
5. Red cedar
6. Red or yellow fir
7. Lovely fir
8. Hemlock
9. Yellow pine
10. White fir
11. Tamarack.

The uses to which the various woods are generally put are as follows:

Uses of woods of trees in Mount Rainier Reserve, Washington.

Bridge timbers	Red and yellow fir.
Lumber	Red and yellow fir, red cedar, tideland spruce, yellow pine, white pine, noble fir, lovely fir.
Shingles	Red cedar, white fir.
Piles	Red fir.
Telegraph poles	Red cedar.
Railroad ties	Tamarack, red and yellow fir, white pine, red cedar.
Fence posts and fuel	All kinds.
Paper pulp	The following trees in the order of their importance: Tideland spruce, cottonwood, quaking aspen, white fir, red and yellow fir, hemlock, maple.
Furniture and cabinetwork	In addition to the lumber woods enumerated some oak, ash, and maple have been used.

MARKETS AND PRICES.

In the absence of railroads and other well-established lines of travel the various divisions of the reserve are, by watersheds, commercially tributary to the outlying markets, namely, Tacoma, Chehalis, Portland, and North Yakima. The following tables show these watersheds and the markets which they at present would naturally supply.

Markets for watersheds in Mount Rainier Reserve, Washington.

Watersheds.	Area.	Tributary to—
	Acres.	
White River	156,160	Tacoma.
Puyallup River	117,840	Do.
Nisqually River	78,000	Do.
Cowlitz River	291,200	Tacoma or Chehalis.
Cispus River	236,000	Do.
Lewis River	222,640	Portland.
Washougal River	3,280	Do.
Rock River	6,040	Do.
Wind River	145,000	Do.
Little White Salmon River	71,650	Do.
White Salmon River	105,600	Do.
Klickitat River	168,680	Do.
Atanum River	40,660	North Yakima.
Tieton River	169,000	Do.
Naches River	327,170	Do.
Yakima River	7,680	Do.

Prices of fir lumber in markets adjacent to Mount Rainier Reserve, Washington.

Grade.	Size.	Finish.	Per M feet B. M. at— Tacoma or Portland.	North Yakima.
	Inches.			
Common	1 by 12	Rough	$7.50	$13.50
Do	do	Surface 2 sides	10.50	16.50
Flooring V. G.:				
Number 1	1 by 4	Dressed and matched	19.00	24.50
Number 2	do	do	14.00	19.50
Ceiling:				
Number 1	$\frac{5}{8}$ by 6	Beaded and plain	15.50	19.00
Number 2	do	do	13.50	17.00
Wainscoting:				
Number 1	$\frac{5}{8}$ by 4		12.00	17.00
Number 2	do		10.00	15.00
Shiplap, common	1 by 8		8.50	14.50
Fencing:				
Number 1	1 by 4		7.50	14.50
Number 2	do		6.50	13.50
Pickets	1 by 3 or 1¼ by 1¼.		10.50	14.50
Lath	$\frac{3}{8}$ by 1½ by 4 per 1,000.		1.65	2.75

Prices of cedar run from 25 to 40 per cent more than above.
Prices of spruce run from 10 to 50 per cent more than above.
Prices of hemlock run same as fir (no demand).
Shingles cost from $1 to $3 per thousand, according to quality.

Price of large or long dressed fir timbers at Tacoma.

Size.	Length.	Price per M feet B. M.
	Feet.	
8 by 8 inches	50	$12.50
8 by 8 inches	100	35.00
12 by 12 inches	50	12.50
12 by 12 inches	100	35.00
14 by 14 inches	50	13.25
14 by 14 inches	100	37.50
16 by 16 inches	50	14.00
16 by 16 inches	100	40.00
18 by 18 inches	50	15.50
18 by 18 inches	100	44.00
20 by 20 inches	50	17.00
20 by 20 inches	100	48.00
22 by 22 inches	50	20.00
22 by 22 inches	100	53.00
24 by 24 inches	50	23.00
24 by 24 inches	100	59.00

Prices of larger timbers are special.

UNDERBRUSH.

Small areas on the eastern slope are of open pine forests, carpeted with pine grass (*Calamagrostis suksdorfi*) and without litter or underbrush, but the general statement is true that on both slopes of the mountains the underbrush is heavy as compared with eastern forest areas, and on the western slope it is not uncommon for the growth to be so rank as to be impenetrable.

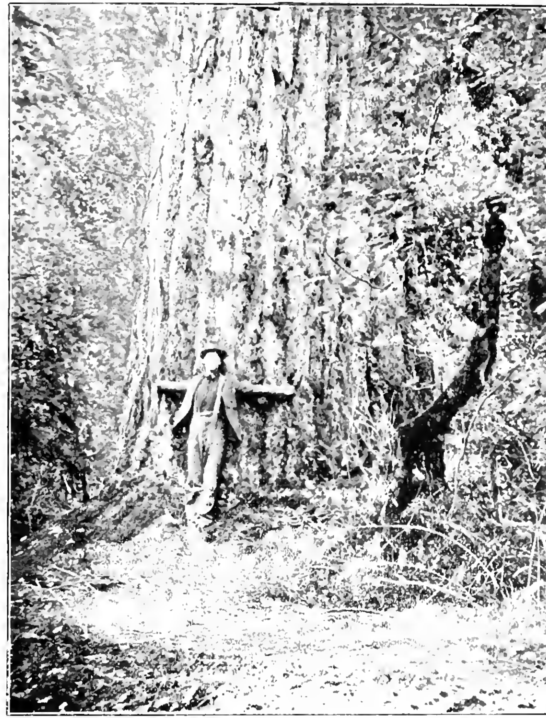
The term underbrush as here used does not include young trees of the same species as those composing the forest, nor does it include grasses, sedges, weeds, or ferns. In the typical forest of conifers there is considerable growth of the deciduous shrubs, which are properly included as underbrush and are so called locally. The species common to both slopes are as follows:

Underbrush in Mount Rainier Reserve, Washington.

SPECIES FOUND THROUGHOUT THE RESERVE.

Oregon grape	Berberis nervosa Pursh.
Washington holly	Berberis aquifolium Pursh.
	Pachystima myrsinites Raf.
Bearberry	Rhamnus purshiana DC.
Soapwood	Ceanothus velutinus Dougl., common.
	Ceanothus sanguineus Pursh.

A. MAPLE GROVE



B. YELLOW FIR 12 FEET IN DIAMETER.

Vine maple	Acer circinatum Pursh.
Smooth maple	Acer glabrum Torr.
Wild cherry	Prunus emarginata var. mollis Brewer. Prunus demissa Walp.
Wild rose	Rosa gymnocarpa Nutt. Rosa nutkana Presl. Rosa californica Cham. and Schlecht.
Hardhack	Spiræa douglasii Hook.
Arrowwood	Spiræa discolor Pursh.
Alpine spiræa	Spiræa rosea Gray.
	Spiræa corymbosa Raf.
Mountain ash	Pyrus sambucifolia (Cham. and Schlecht) Roem.
Crab apple	Pyrus rivularis Dougl.
Juneberry	Amelanchier alnifolia Nutt.
Thimbleberry	Rubus nutkanus Moc.
Salmon berry	Rubus spectabilis Pursh.
Raspberry	Rubus leucodermis Dougl.
Blackberry	Rubus ursinus Cham. and Schlecht.
Snowy or birds'-foot bramble	Rubus pedatus Smith.
Downy bramble	Rubus lasiococcus Gray.
Grease wood	Purshia tridentata DC.
Nine-bark	Neillia opulifolia B. and H.
Mock orange or wild syringa	Philadelphus lewisii Pursh.
Red-flowering currant	Ribes sanguineum Pursh.
Western fetid currant	Ribes bracteosum Dougl.
	Ribes viscosissimum Pursh.
	Ribes cereum Dougl.
	Ribes ciliosum Howell.
Prickly gooseberry	Ribes lacustre var. molle Gray.
Black-berried gooseberry	Ribes divericatum Dougl.
Devil's walking club	Fatsia horrida B. and H.
Canada dogwood	Cornus canadensis Linn.
Western dogwood	Cornus nuttallii Aud.
White-berried dogwood	Cornus pubescens Nutt.
White elder	Sambucus melanocarpa Gray.
Red-berried elder	Sambucus racemosa Linn.
	Sambucus glauca Nutt. ?
Viburnum	Viburnum pauciflorum Pylaie.
Snowberry	Symphoricarpus racemosus Michx.
Western honeysuckle	Lonicera ciliosa Poir.
Bush honeysuckle	Lonicera involucrata Banks.
Red huckleberry	Vaccinium parvifolium Smith.
Myrtle-leaved huckleberry	Vaccinium myrtilloides Hook.
Small red huckleberry	Vaccinium myrtillus var. microcephyllum Hook.
Cranberry	(species not determined.)
Manzanita	Arctostaphylos tomentosa Dougl.
Kinnikinick	Arctostaphylos uvaursi Spr.
Mountain salal	Gaultheria ovatifolia Gray.
Pale laurel	Kalmia glauca Ait. var.
	Menziesia ferruginea Smith.
White rhododendron	Rhododendron albiflorum Hook.

Labrador tea	Ledum latifolium Ait.
Dwarf birch	Betula glandulosa Michx.
Mountain alder	Alnus sinuata Ryd.
	Alnus rhombifolia Nutt.
Hazle	Corylus rostrata Ait., very common.
Bee willow	Salix sitchensis Sanson.
Marsh willow	Salix lasiandra Benth.
Quaking aspen	Populus tremuloides Michx.
Alpine juniper	Juniperus communis Linn.

SPECIES FOUND ONLY ON THE WESTERN SLOPE.

Madroña	Arbutus menziesii Pursh.
Salal	Gaultheria shallon Pursh.
State flower	Rhododendron californicum Hook.
Honeysuckle	Lonicera hispidula Dougl.
Black huckleberry	Vaccinium ovatum Pursh.

SPECIES FOUND ONLY ON THE EASTERN SLOPE.

Scrub oak	Quercus garryana Dougl.
Dogwood	Cornus stolonifera Michx.
Oregon grape	Berberis repens Lindl.
Sagebrush	Artemisia tridentata Nutt.
Missouri currant	Ribes aureum Pursh.
Small sagebrush	Aplopappus bloomeri Gray.

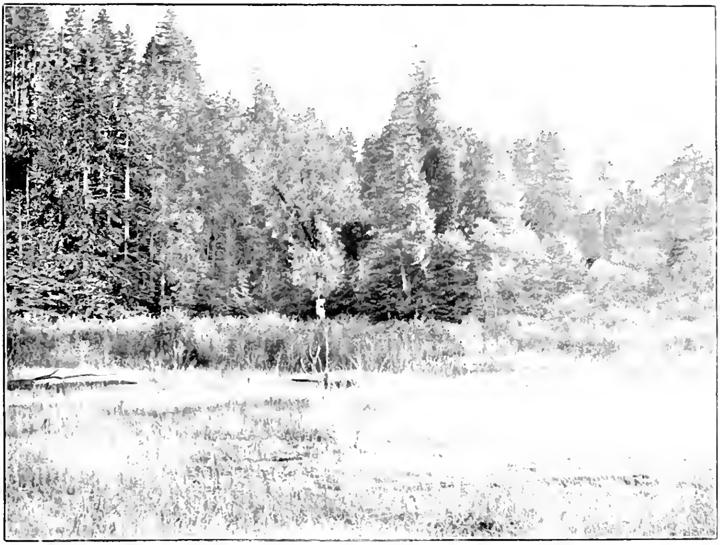
FOREST LITTER.

On the eastern slopes the forests are generally open, travel off the trails being possible with pack animals, although sometimes difficult and slow. On the western slopes the forest litter makes travel on the trails or roads imperative, and the explorer or prospector must expect to carry his pack on his back and climb over or crawl under the fallen logs that cover the ground. Sometimes these logs are piled 20 feet high, as mute but eloquent reminders of an unusually heavy windstorm. In such areas logging becomes difficult and expensive, as it increases the proportion of "swampers" in the logging crew.

The litter is a menace to the forest, inasmuch as it is the best conductor for fire, and when logs are favorably placed a heavy downpour of rain will not extinguish the flames, which, surviving, proceed with the work of destruction.

HUMUS.

An important factor in the forest growth is the humus, which forms the upper soil everywhere, excepting where the fires have been so severe as to utterly destroy it. This loose deposit of fallen and decayed vegetation is most abundant in the heavy and unharmed forests, where it is from 3 inches to a foot in depth. As it is a retainer of moisture and a protector for the seedlings, the restocking of burned areas is a slow process if the humus has been totally destroyed.



A. FIR, MAPLE, AND ASH TREES.

B. MOUNT HOOD; MOUNTAIN FIR IN FOREGROUND

On the steeper hillsides it acts as a retarding element to the surface drainage, preventing the sudden flooding of the streams during rains, and also preventing their entire cessation during the dry season. On the eastern slope, in the watershed of the Yakima River, the surface flow continues to feed the river for three months after the cessation of the winter rains and snows, and as the waters of this river are largely used for irrigation, the importance of the forest cover and the humus is easily seen. Lands are irrigated from April to October, inclusive, the largest demand for water generally being made in July, at which time at least one-half of the flow is from the melting snows. The time is rapidly approaching when the entire flow of this river will be utilized in the necessary and desirable conversion of deserts into gardens, and it is conservative to say that a fall of 1 foot in the river affects 300,000 acres of land.

FIRES.

EXTENT AND LOCATION OF BURNS.

The areas which may be classified as burns amount to 326,590 acres, or about 15¼ per cent of the total area of the reserve. Of this area about two-thirds are on the western side of the Cascade Mountains.

Ancient burns, of which traces still remain in the standing timber, cover probably 40 to 50 per cent of the area of the reserve, but being restocked with trees of large size, these areas can not be called burns. The fires of comparatively recent occurrence, whose effects may be studied and compared, have results depending upon the nature of the forest, the time of year, and the winds. A fire may clear the ground of brush, litter, and humus, but not materially damage the standing trees beyond charring them to a height of 10 or 15 feet. If more severe it may consume some of the standing trees without much regard to species or location, on account of the proximity of underbrush and litter to the bases of the trees destroyed. Such fires leave standing burned snags surrounded by green and unharmed old timber.

A "burn" results in the total destruction of all vegetation within the limits of the burned area, leaving only standing snags and stumps, and the ground covered with partly consumed logs. Small areas may be "clean burns" and show few signs of the former forest, but instead be a desert of burned sandy soil in which the traveler will sink ankle deep. The burns bear little relation either to topography or the kind of timber, their boundaries and extent having been determined by the initial fire and the direction of the wind. The smaller deciduous trees which have their habitat in the moist bottoms, such as alder and maples, are more immune than their coniferous associates, but even they do not always escape.

The great burns in the Cowlitz watershed occurred in 1841 and 1856, but portions of the area have been burned or reburned at intervals during the past ten years. Over large and irregular areas this region is restocked with the same species of trees which border it and probably constituted the original forest. In this restocking the noble fir (*Abies nobilis*) takes an important part, and, together with the other firs, would rapidly retimber this most unsightly region if fires could be prevented. On the Sawtooth Range a large fire occurred in 1896, and reliable witnesses say that one tree burned for six months.

The hills on the north side of the Cowlitz River have been burned over several times since settlement, the last burn being three years ago. In this and adjoining areas the second growth after the burn is very rapid.

From testimony of various Indians regarding the "big fire" it appears that it was of unusual severity. Many Indians and stock perished, and the few saved who were in its path were submerged in the river for protection. The heat was so intense as to kill some of the fish in the river.

The large burn on Bald Mountain occurred about 1860 and must have been a very severe and destructive fire, destroying all the vegetation and humus and exposing the thin scoria soil, which barely covers the eruptive rocks. Under such adverse conditions the process of restocking is necessarily slow, particularly as the seedlings must advance up hill unprotected.

The burn about Juniper Mountain and the head of McCoy Creek occurred in July, 1898. At about the same time a portion of the southwest slope of Mount Adams was burned, leaving an unsightly patch of dead snags which detracts from the beauty of the mountain view.

The recent burns near Steamboat Mountain and over scattered patches to the southward have occurred periodically during the past twenty years, the last and most extensive fire being in 1897.

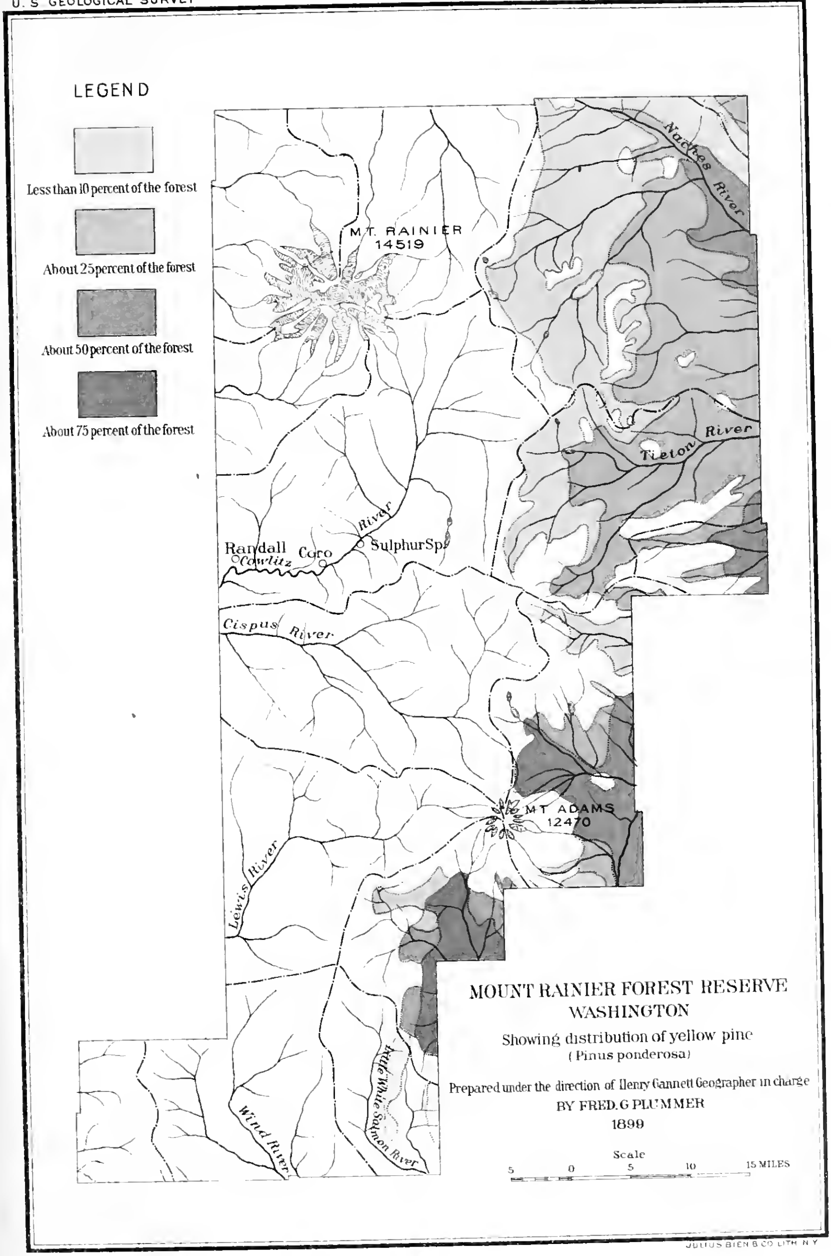
On the eastern slope of the Cascade Mountains the majority of the burns have occurred during the past decade, those of the Atanum and Tieton watersheds having mostly occurred since 1896.

A portion of the basin of Silver Creek was burned August 10, 1898, and at this time ashes fell at Longmires Springs, which is distant about 20 miles. Mineral Creek Basin, which is a tributary to American River, burned over in 1895.

CAUSES OF FIRES.

The fires which have occurred in the reserve may be traced to the following causes:

Campers and packers build their fires against logs or trees and neglect to extinguish them. Small fires that are built in the open do



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not spread unless the humus is deep and dry. They will smolder until fanned into flame by the wind.

Sheep men start fires to promote the growth of grass near the summits, believing that the destruction of the timber is generally followed by a growth of those grasses upon which sheep will feed. Severe fires also have the effect of clearing the ground of underbrush and litter and make it easier and safer to drive sheep from point to point.

Prospectors fire the timber with the object of clearing the ground to make prospecting easier. A great many miners are strongly opposed to this method as it gives a very dirty area to work in and the legitimate miner needs the timber for his shafts and tunnels.

Settlers start fires for the purpose of clearing the land for cultivation. As the settlers do not like to go to the trouble of carrying their brush or slashed timber away from the standing timber, they burn it where it falls in slashing.

Indians also start fires on the slopes and summits for the purpose of promoting the growth of huckleberries, blackberries, and raspberries, and also to drive game.

Camping parties often set fire to the resinous trees simply for the the pleasure of seeing them burn. Cases of this kind were not uncommon, but of recent years sentiment has been so strongly against this practice that the evil has almost ceased to exist.

Lightning also starts fires.

Since the inauguration of the present forest policy the causes may be briefly stated as ignorance, carelessness, and lightning. The expert woodsman, trapper, hunter, or camper for pleasure is careful about his fires and knows how to build them so that they will not spread and burn his tent and outfit. His cooking fire is never larger than necessary to hold a coffee pot, kettle, and skillet, and is usually made between two rows of rocks or two small green or wet logs. The fire will measure 8 by 20 or 30 inches, and within a half hour from the time of starting every small twig and dry cone in its immediate vicinity has been used for fuel and to safeguard against burnt shoes or trousers. The tenderfoot, on the contrary, builds his fires large and open, and the chance of their spreading is much increased if they are against logs or trees.

The fixing of a cause for any stated fire is almost impossible, unless lightning was the cause. Sheep men, prospectors, hunters, and ranchers accuse one another promiscuously, but no reliable data are obtainable. In the case of lightning, where the agency of a human being is not involved, some data have been collected and will be here given at the risk of giving that agent more prominence than might be justified were the other causes capable of the same investigation. These well-authenticated instances do, however, prove that lightning can not be omitted from the list of causes, although it may be argued that during an electric storm the precipitation should be so great as to prevent a large fire from catching or spreading.

In May, 1897, lightning struck the timber in Cowlitz Bottom near the town of Vance on several occasions, the largest burn resulting in the destruction of about three acres of timber. In June, 1896, it struck the hills in secs. 1 and 2, T. 12 N., R. 7 E., and a large forest fire in the second growth resulted.

Timber on Juniper Mountain was struck by lightning in July, 1898, and a large burn resulted which destroyed considerable fair timber.

In the basin of the South Fork of the Rattlesnake on July 22, 1898, at 7.30 p. m., lightning struck a tree and also killed three horses belonging to Joseph Melini. Another stroke set a small fire which burned for ten or fifteen minutes. Both fires were extinguished by the accompanying downpour of rain.

On August 10, 1898, lightning struck several trees in Silver Creek Basin and a large burn resulted. There was no rain that day, nor was there at Longmires Springs, distant 20 miles, although the day was heavily clouded.

Two fires were started by lightning on July 28, 1899, in sec. 36, T. 7 N., R. 9 E., but did not spread beyond the trees struck.

RESTOCKING OF BURNED AREAS.

All of the restocking of the reserve is natural. No work has been done by man toward reseeding with the best species nor eliminating from young second growths the undesirable species. All of the activity thus far has been toward protection against fire, which may in a day destroy what would balance the work of years.

The process of reseeding is rapid. All of the timber trees seed abundantly and at a season when the high winds may distribute the seeds over large areas. It is doubtful if any assistance from man would noticeably affect the progress of this reseeding, which, if conditions of soil permit, results in a thicket of small growth in spite of the numerous animals which destroy seeds. In cases where a fire was not severe and representatives of one or more hardy species withstood the flames, the restocking begins from these survivors, which are not always the best timber species. The mountain hemlock (*Tsuga pattoniana*) seems to resist fire more successfully than the other species common in the alpine zone, and the tamarack (*Larix occidentalis*) survives best in the middle zone. In Naches Valley above the junction of Bumping River there is a very old burn. A few yellow pine and red fir of the old forest are still standing, and the heavy second growth is of the same species, with the addition of tamarack. Very small recent fires in the same area have injured many of the trees and made clean burns in some locations. From Naches Pass just outside the reserve for 5 miles down the river and into the reserve there is an

A. MOUNT RAINIER FROM GOAT MOUNTAIN.

B. BURN, WITH SECOND GROWTH

old burn about 2 miles wide, which is now partly second growth white fir and tamarack, with willows along the banks. In the watershed of Atanum River there are indications that the tamarack stood the fires of an ancient burn better than other species.

After a clean burn the restocking must proceed from the bordering forests, and it is observed that although these bounding forests may be mixed, one species often predominates in the new growth. This fact may be accounted for by assuming that a favorable wind prevailed when that particular species was in mature fruit, and that the soil conditions in the burn were such as to give encouragement to that species. In this respect the tamarack easily takes the lead in eastern Washington, and the hemlock (*Tsuga mertensiana*) in western Washington. Of all the conifers these two species have the lightest cones and seeds, and are most exempt from the attacks of squirrels and chipmunks. These are among the least valuable of the timber trees, and it happens that the best of the pines, the white pine (*P. monticola*), and the best of the firs, the noble fir (*A. nobilis*), have large and heavy cones, and being subject to these depredations are checked in their efforts at restocking.

The grazing of sheep and other stock upon burned areas certainly retards their restocking with timber. If stock pasturing were prohibited upon all burned and low timberless areas until the restocking had resulted in such sufficient stand and age of timber trees that further protection would be unnecessary, it would remove a serious enemy from the field, and in all probability would result in extinguishing forest fires in their incipiency.

TIMBERLESS AREAS.

There is no altitude which may be termed a timber limit. This results from the fact that the bold topography of the reserve and the presence of numerous perpetual snow fields and glaciers cause different climatic conditions to obtain in areas not widely separated. Upon the slopes of Mount Rainier the alpine trees cover the sharp ridges to an elevation of 7,200 feet, and above this only a few scattering procumbent individuals find shelter behind some rock or crag. The extreme altitude there reached by trees may be stated at 7,600 feet, but at Goat Peak the same forms reach an altitude of 8,400 feet. The difference of latitude favoring Goat Peak is only a third of a degree, but the local climatic conditions are quite different. At lower elevations than these, however, many rocky peaks are often too exposed to permit a growth of trees or the accumulation of a scanty soil, excepting in the rock crevices where the hardy little alpine flowers will find strong root hold.

Cliffs at all altitudes are often too steep and smooth to permit the spread of the timber which struggles for existence on the talus slopes below. Often the talus slopes are timberless, particularly when recent or when composed of fine chips, but in the majority of cases the pines and firs manage to advance over these uninviting areas.

Upon the slopes of Mount Rainier the glaciers flow to the lower altitudinal limit of 3,300 feet, and these areas are of course timberless, as are the perpetual snow fields which border the glaciers or lie upon the ridges which form the divides between the "cradles" of the glaciers.

The great timberless area of eastern Washington, or the "arid region," does not extend to the boundary of the reserve, but approaches it so closely that it is germane to the subject.

It appears to the most casual observer that the trees of the lower mountain slopes are forcing their way over these arid regions. A similar phenomenon has long been observed on the beautiful parked prairies of western Washington near Tacoma, where the advance of the red firs (*Pseudotsuga taxifolia*) has been as great as 25 feet per year. On the eastern slopes of the Cascade Mountains it is the yellow pine (*Pinus ponderosa*) that takes the lead among the conifers in attacking these arid regions. The red fir follows closely, seldom being more than 2 miles behind, and is in turn closely followed by the tamarack (*Larix occidentalis*). Other species follow rapidly, depending upon topography and soil.

TIMBER CUTTING IN THE RESERVE.

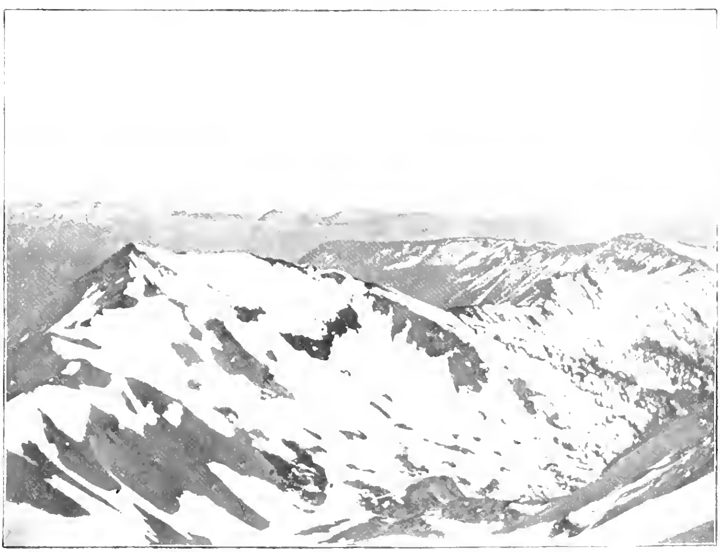
A total area of about 8,000 acres has been cut within the boundaries of the reserve. Of this amount 40 per cent has been cut by actual settlers and the balance by loggers.

The largest area is along Tieton River, from the reserve boundary westward. The lumber is reported as used for fluming and other construction work on the Selah irrigating canal. The cordwood from the same area was marketed in North Yakima.

At Tannum Lake about 200 logs have been cut and dressed on two sides ready for the construction of an impounding dam at the foot of the lake. This work was done in 1891 under the direction of the Yakima Investment Company, and most of the logs have been piled up at the point of proposed construction. Tannum Lake and Lakes Kitchelos, Katchess, and Clealum, which lie outside of the reserve, have been considered in connection with the extensive plans for the irrigation of the fertile slopes of the Lower Yakima Basin, which plans have been partly carried to completion. There is little doubt that they will be needed for storage in the future, as the nature of the Yakima watershed causes extremes of high and low stages in the river.

At the Medina mining camp on Silver Creek in Summit district, a small mill has been erected to furnish lumber to be used in the construction of a 5-stamp mill and the necessary fluming and buildings.

A. SUMMIT OF RANGE IN SOUTHERN PART OF THE RESERVE, LOOKING WEST.



B. HEADWATERS OF TIETON RIVER, FROM GOAT MOUNTAIN.

They have slashed an area of about 2 acres and cut a total of about 10,000 feet.

A sawmill in sec. 29, T. 15 N., R. 7 E., was run for a short time. The logging was largely from an area subsequently cleared and cultivated. There are about 10,000 feet of lumber in the mill yard.

A mill situated near Chenowith post-office in sec. 22, T. 4 N., R. 9 E., has cut a total of about 40 acres from patented land within the reserve. Another located in sec. 14, T. 3 N., R. 9 E., outside of the reserve, has cut about 160 acres.

A shingle mill is situated in sec. 20, T. 4 N., R. 9 E., and has a capacity of about 30,000 shingles per day. It cuts from patented lands.

In 1899 a small portable mill was located in sec. 8, T. 12 N., R. 7 E., but is now idle after filling a few small orders. The country tributary to it is patented and settled.

LOGGING CONDITIONS.

It may be said generally that the logging of those areas examined must be by skid and railroads. The only drivable stream is the Lower Cowlitz River, and as there is not much timber in its valley skids or trams will be needed to transfer logs from the timbered slopes of its watershed to the river. The exception to the above general statement is that during flood seasons several of the rivers carry enough water in confined channels to drive logs for short distances, and that shingle bolts, fence posts, and cordwood might be driven during the greater part of the year if drifts and other obstructions are removed. Such rivers are the White, Carbon, Little White Salmon, Cispus, Lewis, Wind, Puyallup, Nisqually, Klickitat, and Naches. With the present method of logging it is not likely that any of these streams will ever be used.

In all the watersheds the method and route of logging is fixed by the location of the main and secondary divides, which are usually sharp and well defined, without table-lands. In such cases the canyon slopes are so steep that log chutes might be used, but the areas tributary to such chutes are generally limited and contain little timber.

With the exception of a short narrow-gage railroad feeding the Oregon Mill Company's mill in T. 4 N., R. 9 E., there are no railroads in the reserve, nor are there any wagon roads over which heavy logs could be hauled. The Northern Pacific Railway Company has made a survey up the Nisqually Valley via Bear Prairie, down Skate Creek, up the Cowlitz and Summit Creek and over Carlton Pass in the Cascade Mountains, thence down Bumping River, but no construction work has been done. The Tacoma and Columbia River Railroad has made a preliminary survey from the end of their line at Lake Park, 11 miles from Tacoma. This survey runs up the Cispus River to Cispus Pass with the expressed intention of tapping a timber belt and certain coal prospects in the Cispus watershed.

SETTLEMENT AND IMPROVEMENTS.

Within the reserve there are 160 settlers, of whom about 75 per cent have made improvements other than the building of houses or cabins. From detail memoranda made during the examination the following figures are obtained:

Improvements in Mount Rainier Reserve, Washington

Number of houses (including trappers and prospectors)	181
Number of barns	90
Number of acres slashed	3,275.85
Number of acres cleared (mostly in pastures)	1,864.75
Number of acres in gardens	65.4
Number of acres in orchards	91.85

Generally the clearing of land for pasturage does not include the removal of large stumps, as this work is expensive, and in some locations would mean $150 per acre. The garden produce is for local consumption and is only limited by climate. The best results are from potatoes, onions, turnips, carrots, beets, parsnips, squash, and small fruits. Corn, tomatoes, and cucumbers are raised, but not to perfection. The orchards are principally of apples, plums, and pears.

GRAZING.

The grazing lands of the reserve are mainly upon the eastern slope of the Cascade Mountains, and have an area of about 800,000 acres.

During the season of 1899 approximately 260,000 sheep were herded on this area. The general method of herding sheep in the State of Washington is as follows: In the late fall and winter the sheep are pastured in the vicinity of their home ranches in the low lands and valleys of eastern Washington, and in severe weather feed on hay. In the early spring, after lambing and shearing, the bands are driven toward the mountains, reaching the reserve in June. They follow the receding snows to the very summits, grazing and browsing upon the new growth of grasses and deciduous vegetation. Late in August they commence to work down to the lower altitudes, and generally leave the reserve about the 1st of October.

As might be expected, there is a wide divergence of opinion regarding the advantages or disadvantages resulting from this practice, and the sheep owner's position has become one of active defense against public sentiment.

The arguments presented against the grazing of sheep in the reserve are as follows: (1) That the sheep men fire the forests for the purpose of promoting the growth of the forage plants. (2) That the sheep browse upon the young timber trees and trample out the seedlings. (3) That the removal of underbrush causes the streams to become more

A MOUNT ADAMS.

B CISPUS RANGE FROM GOAT MOUNTAIN

sensitive to melting snows, and the summer flow of rivers used for irrigation is thereby decreased. (4) That the sheep pollute the streams. (5) That the natural beauty of the reserve is partially destroyed.

The sheep owners and herders not only deny all the above, but claim in addition: (1) That the removal of the underbrush by the browsing of sheep lessens the liability of fires spreading. (2) That the herders are exterminating the bears, cougars, wildcats, wolves, and coyotes, which prey upon domestic animals.

There is little doubt but that sheep men have started fires, and that burns more or less extensive have resulted, but it is equally true that by reason of the strict regulations and enforcement of the law, together with a regard for their own interests, due to a wholesome fear of the cancellation of their permits, the practice has ceased, and any fires now originating with the sheep men are isolated cases resulting from carelessness.

Moreover, it is contended that setting fire to the timber does not necessarily result in the increase of the areas for pasturage. A clean burn more frequently results in a rank growth of huckleberries, and if the burn is not clean the ground remains covered with charred logs and snags, making travel slow and dangerous and the area often unfit for sheeping. The coarse grasses and weeds that immediately follow the fires are not the best forage, and it may be several years before they are succeeded by the better varieties.

It is a fact that the greatest number of burns and also those of the greatest extent are in portions of the reserve which have not been sheeped, and this fact has at least a general bearing on the subject, as these areas of great burns are on the western slopes and in the regions of greatest annual precipitation.

The claim that the sheep browse upon the young timber trees is not well founded so far as it relates to the conifers, and within the grazing area there are no deciduous trees of any value excepting the oak (*Quercus garryana*), and that is generally of a size only fit for fuel. Sheep, cattle, and horses will not eat foliage from the pines, firs, and other evergreens which comprise the timber of the reserve, unless driven to it by a hunger that is almost starvation. In the immediate vicinity of the separating corrals, where bands of sheep may be confined for one or two days during the process of separating, small evergreens were nipped by the sheep, and along the beaten and oversheeped trails the same thing may be noticed, but the damage is insignificant and only worthy of mention as an exception. During the examination our pack animals were several times in desperate need of pasturage, as our route of travel took us over miles of deep snow, which covered everything but the timber trees. These, however, the animals would not touch. On Pisco Ridge (outside the reserve), at an elevation of 6,000 feet, we found the remains of over 20 horses, which had perished in the snow, huddled together in a bunch of young firs and pines. They had pawed the ground for grass roots, and had gnawed the bark from the trees and browsed on some of the foliage, but not to any extent.

There is no doubt that the sheep trample out seedlings of the conifers as they do of other trees and shrubs. Along the routes of sheep travel the forest floor is sometimes powdered by their sharp hoofs and all traces of undergrowth obliterated, and if this condition prevailed over a burned area the process of restocking would be very slow.

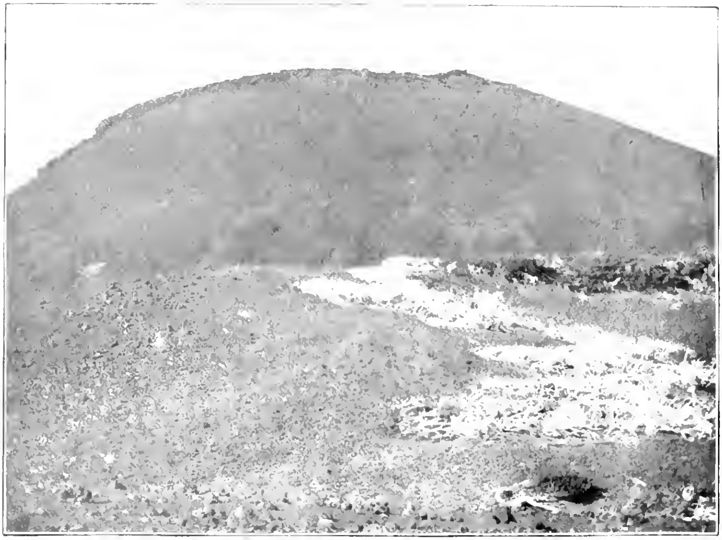
All of the conifers set cones in abundance, but not one seed in 100,000 produces a mature tree under ordinary conditions. Squirrels, chipmunks, and birds eat most of the seeds; forest shade kills many of the seedlings, and in the open it is a case of survival of the fittest. Inasmuch as a sufficient number of the seedlings generally survive to take part in the final competition and form the "thickets" so commons in the more open areas, it is evident that the enemies, including sheep, do not seriously affect the final result as stated.

The effect of underbrush and forest cover in retarding or accelerating the melting of snow is easily demonstrated by observation in the area of the Cascade Mountains examined. However, if it be assumed that the snow melts more quickly in the open many locations may be cited as evidence, and if the contrary be assumed the evidences are quite as numerous. This is for the general hypothesis, but there are details of exposure and altitude which enter into the problem and make it capable of solution. The masses of compact snow which are found in the open or timberless heights late in the summer are always upon hillsides protected from the warm chinook winds, and these are generally the northern and eastern slopes. Upon timbered mountains of equal altitude and where similar climatic conditions prevail the same slopes hold snow the longest. The effect of the underbrush and forest litter on the melting of snow is one which the traveler in these high altitudes is forced to observe for his own safety. It is only upon the hard snow which hides no brush or logs that safe footing is found. Wherever a log or brush exists the snow is soft and melting and the pack animals and men fall through, a matter of some consequence where the snow is over 6 feet deep.

Although the temperature in the forest may be slightly higher than in the open, for any given altitude, there can be no doubt that a stand of timber protects the snow from the warm winds and prevents the sudden rise of a stream. The underbrush does not give this protection, but is an agent in preventing the compacting and hastens the melting of the snow. To summarize: The snows will remain longest (other conditions equal) in—

(1) A forest without underbrush or litter.

(2) An open without brush or litter.



A. RECENT CINDER CONE ON NORTH SLOPE OF MOUNT ADAMS.

B. MOUNT ADAMS, WITH MOUNTAIN FIR IN FOREGROUND

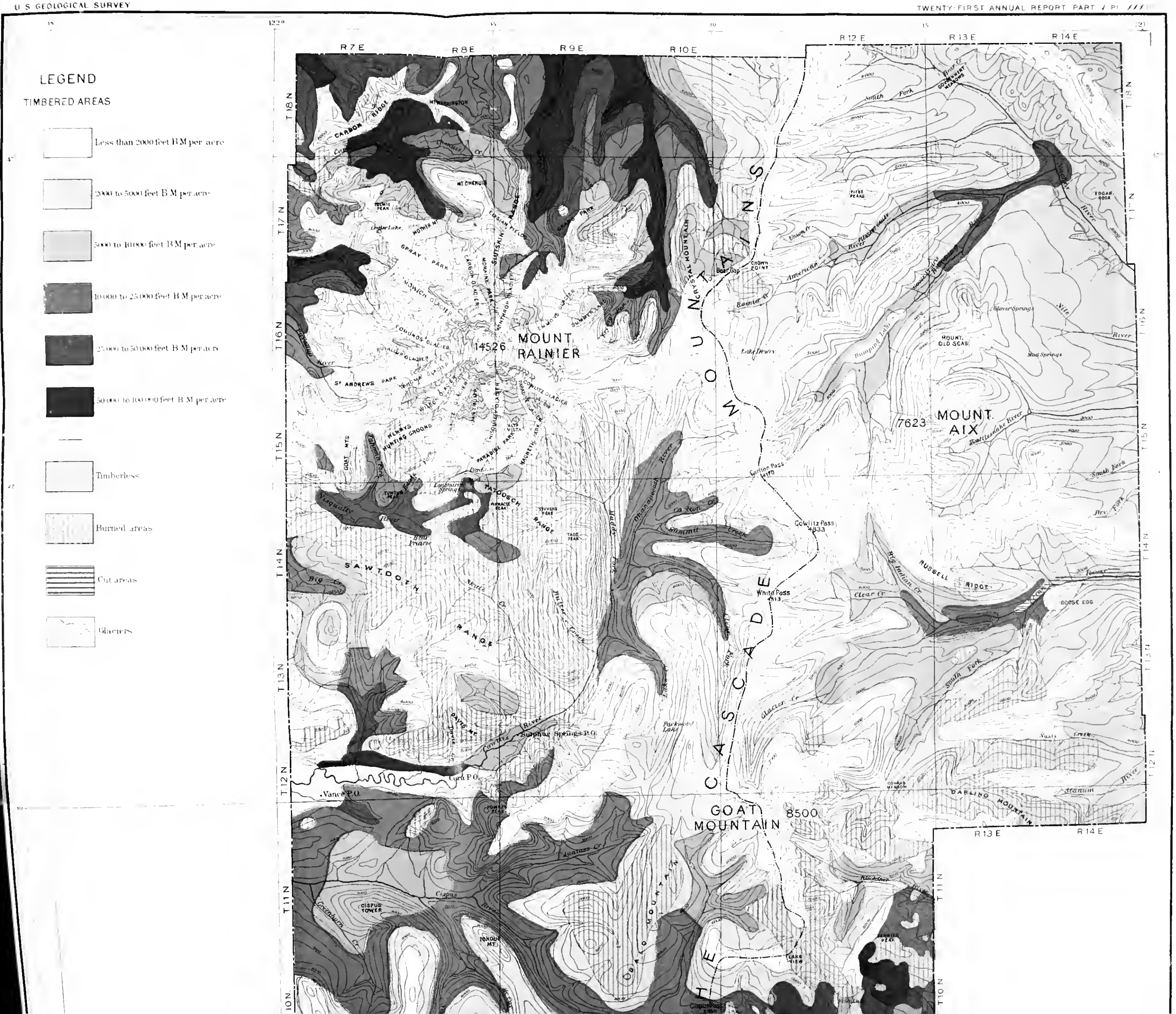
(3) A forest with underbrush or litter.

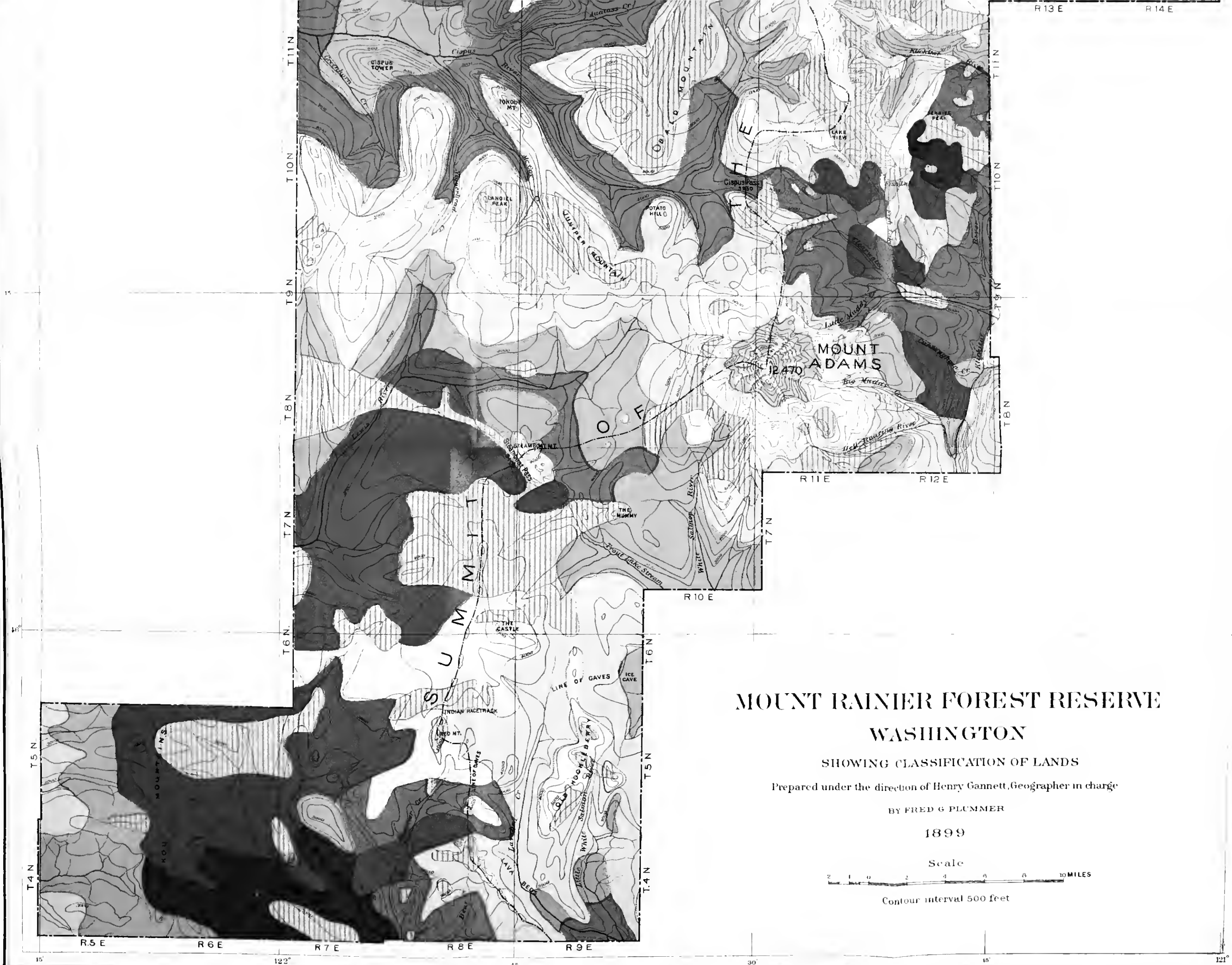
(4) An open with brush or litter.

The question of the pollution of the streams by sheep is one rather for the future than for the present, inasmuch as provision is made that the sheep "shall not be corralled within 500 yards of any running stream or living spring." If the corrals bordered on or had surface drainage into the streams the waters would be polluted in sentiment if not in fact when they reached the distant settlements, and sentiment is a strong factor when it applies to drinking water. One specification for good drinking water is that it must not contain more than one part by weight of dry organic matter in 100,000 parts of liquid, and it is safe to say that this limit is not exceeded in the river waters even in the immediate vicinity of the corrals. The fact that running waters are self-clarifying is generally conceded, although not to the extent set forth by Dr. H. Letheby, medical officer of health for the city of London, in relation to the Thames. His statement is that "sewage" when it is mixed with twenty times its volume of running water and has flowed a distance of 10 or 12 miles is absolutely destroyed; the agents of destruction being infusorial animals, aquatic plants and fish, and chemical oxidation. The question of pollution is therefore one to be considered in the precautionary way, and this has been done.

The scenery of the reserve is on too grand and extensive a scale to be affected by any operation of man, such as grazing or mining. The burns are the only disfigurement to the magnificent views which reward the climber of the peaks. Areas of particular beauty or novelty should be included in the National Park, on which pasturing is not allowed.

The Secretary of the Interior on June 30, 1897, promulgated rules and regulations relating to forest preservation, among which was the following: "13. The pasturing of live stock on the public lands in forest reservations will not be interfered with so long as it appears that injury is not being done to the forest growth and the rights of others are not thereby jeopardized." From my observations the injury done the forest growth by sheeping is not serious, and the attendant evils can be and are being guarded against.


LEGEND
TIMBERED AREAS
Less than 2000 feet B M per acre
2000 to 5000 feet B M per acre
5000 to 10000 feet B M per acre
10000 to 25000 feet B M per acre
25000 to 50000 feet B M per acre
50000 to 100000 feet B M per acre
Timberless
Burned areas
Cut areas
Glaciers
R 7 E
R 8 E
R 9 E
R 10 E
R 12 E
R 13 E
R 14 E
T 18 N
T 17 N
T 16 N
T 15 N
T 14 N
T 13 N
T 12 N
T 11 N
T 10 N
MOUNT RAINIER
14526
MOUNT AIX
7623
GOAT MOUNTAIN
8500
CASCADE MOUNTAINS
CARBON RIDGE
MT. CHENUIS
SPRAY PARK
ST ANDREWS PARK
SAWTOOTH RANGE
TATOOSCH RANGE
RUSSELL RIDGE
DARLING MOUNTAIN
Carlton Pass
Cowlitz Pass 4833
White Pass 4513
Sulphur Springs P.O.
Cora P.O.
Vance P.O.
Nisqually River
Cowlitz River
American River
Bumping Lake
Lake Dewey
Parkwood Lake
Clear Cr.
Summit Creek
CISPUS TOWER



MOUNT RAINIER FOREST RESERVE

WASHINGTON

SHOWING CLASSIFICATION OF LANDS

Prepared under the direction of Henry Gannett, Geographer in charge

BY FRED G PLUMMER

1899

Scale

2 1 0 2 4 6 8 10 MILES

Contour interval 500 feet

M. W. Gorman

DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

THE EASTERN PART OF THE WASHINGTON FOREST RESERVE

BY

MARTIN W. GORMAN

EXTRACT FROM THE NINETEENTH ANNUAL REPORT OF THE SURVEY, 1897-98
PART V, FOREST RESERVES—HENRY GANNETT, CHIEF OF
DIVISION OF GEOGRAPHY AND FORESTRY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1899

THE EASTERN PART OF THE WASHINGTON FOREST RESERVE

BY

MARTIN W. GORMAN

EASTERN PART OF WASHINGTON FOREST RESERVE.

By Martin W. Gorman.

ITINERARY.

In compliance with instructions to act as field assistant in making an examination of the woodlands and forests of the eastern part of the Washington Forest Reserve and to collect specimens of the vegetation of the region, I proceeded to Lake Chelan, where on August 7, I joined the topographic party engaged in surveying there, in charge of Mr. W. T. Griswold. The collecting of specimens at once began and on August 9 the party proceeded up Twenty-five Mile Creek to the neighborhood of Pyramid Peak, which was reached on the 10th, ascending from the lake level—1,100 feet—to 6,169 feet. Numerous trips were made to the surrounding crests and ridges, the region from the foot of the yellow-pine belt to the timber line having been passed in the ascent. On the 14th the party returned to the lake and made a few short trips to the south side of Twenty-five Mile Creek, to Grade Creek, and to the head of Camas Creek. From the 19th to the 25th the shores, creeks, and hills on both sides of the lake were examined as far north as the vicinity of Prince Creek, and on the 25th the main camp was moved to Mitchell Creek, from which point numerous short excursions were made to the surrounding hilltops and divides. Leaving camp on August 31, we proceeded to the head of Poison Creek and made a temporary halt on the Methow side of the divide at 5,100 feet, where, on September 2, we experienced our first snow of the season. On the 4th we descended one of the ridges to Squaw Creek, which we followed to the Methow River, thence to the Columbia, and along the latter through Antoine Coulée to Lake Chelan, where we again joined the main camp on Mitchell Creek on September 7, and remained till the 12th. September 13 we moved to Stehekin, and on the 14th returned to Lakeside, where preparations were begun for sounding Lake Chelan. The time from September 15 to October 1 was spent in preparing the apparatus and sounding the lake, and on October 2 and 3 a side trip was made about 12 or 13 miles up Railroad Creek. From October 5 to October 17 the Stehekin Valley, Horseshoe Basin, Cascade Pass, Doubtful Lake, and

Bridge Creek were examined; a severe rain and snow storm on the 11th, 12th, and 13th interfered somewhat with the progress of the work. On the 18th and 19th a trip was made up Bridge Creek (on the South Fork and the East Fork), Copper Creek, and State Creek to the summit of the divide—5,800 feet—and on the 20th and 21st down Early Winters Creek to Methow River and up the latter to its confluence with Lost River. From this point an effort was made on the 22d and 23d to reach the boundary line by way of Rattlesnake Creek, Slate Pass, and Windy Pass, but the snow was about 18 inches deep in both passes, and we were obliged to return after reaching a point 8 or 10 miles from the boundary line. The return trip, which occupied the 24th, 25th, and 26th, was made down Rattlesnake Creek and the west side of Methow River to a point opposite Winthrop, thence westward to the Twisp River, up that stream to the mouth of War Creek, along the north side of the latter to the divide—6,760 feet—and thence through War Creek Pass to Stehekin, where we arrived on the night of the 26th. Lakeside, at the foot of Lake Chelan, was reached on October 31, and the work of the season was thus finished.

It is somewhat to be regretted that the work was not begun at least a month earlier, as the ground to be covered was so extensive that it could not be examined as thoroughly as desirable in the time available.

Owing to the dryness of the climate and the rapidity with which vegetation advances in the hot early summer season, I would suggest that the collection of a set of botanical specimens from this region be begun not later than the end of June, as on my arrival on August 6 some orders, such as the Liliaceæ and a great portion of the Poaceæ, were too far advanced for collecting, and many of the specimens I collected were only to be had in ripe fruit.

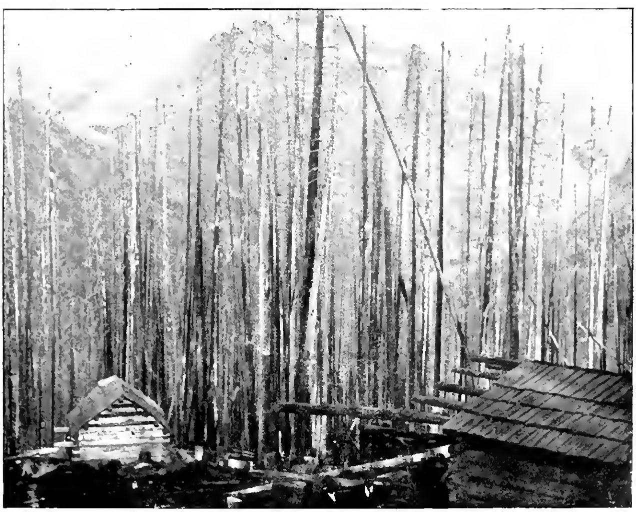
TOPOGRAPHY.

The portion of the Washington Forest Reserve described in this report is that east of the summit of the Cascade Range. It is an oblong tract, 72 miles in length from north to south and averaging about 37.7 miles from east to west, with the western line somewhat sinuous and irregular, owing to the irregular course of the crest line. It contains, in round numbers, about 2,700 square miles.

Besides the Cascade Range, the highest point on the crest line of which probably does not exceed 9,000 feet (Glacier Peak, ~~about 9,500~~ 10,486 feet, being a little west of the main divide), the principal other mountains in the reserve constitute the Chelan Range, to the west of Lake Chelan, which divides its drainage basin from that of the Entiatqua River. The crest line of this divide ranges from 6,330 to 7,398 feet, the latter being the height of Stormy Mountain.

The Methow Range, to the east of Lake Chelan, divides the latter from the drainage basin of the Twisp and Methow rivers. The crest line of this divide ranges from 5,353 to 8,000 feet. The most prominent

A. VIEW UP RAILROAD CREEK



B. BURN IN STEHEKIN VALLEY

peaks in the vicinity are South Navarre, 7,899 feet, North Navarre, 7,983 feet, and an unnamed mountain a little to the east of Navarre, having two peaks, the south one 7,785 feet and the north one 7,874 feet.

To the north, among the most prominent summits are a pair of remarkable, round, dome-like peaks, known as "The Towers," with a height of probably 7,000 to 7,500 feet, while there are numerous unnamed peaks ranging from 6,000 to 8,000 feet.

Twenty-seven miles north of Lake Chelan there is an old glacial trough, known as "Horseshoe Basin." The floor of the lower basin has an average elevation of 4,300 feet and that of the upper one of about 5,800 feet. The lower basin is surrounded by abrupt horseshoe-shaped walls of rock, as the name indicates, and the upper by rugged, more or less snow-clad peaks, while in late summer both constitute a veritable flower garden to the botanist, as well as a piece of such picturesque scenery that it may be considered by the tourist the gem of the Cascade Range. A small and steadily diminishing glacier, the remnant of one formerly magnificent, still exists in the upper basin, the water from its slowly melting snow and ice falling into the lower basin in seven tiny waterfalls, which unite there into a small stream and become one of the sources of Stehekin River.

At the head of Railroad Creek are two mountains, in close proximity, fully 8,000 feet high, not laid down on the maps, but known locally as "Bonanza" and "North Star," the glaciers on whose sides are the source of four streams, viz, Agnes Creek to the north, Entiatqua River to the south, Railroad Creek to the east, and Suiattle River to the west. The lowest elevation of this part of the reserve is the shore line of Lake Chelan—1,108 feet—while in close proximity on its west side is Pyramid Mountain, with an altitude of 8,281 feet.

One of the most noticeable features of the whole region is the large number of ancient water levels, or, as they are locally called, "benches." The best marked of all these is probably the one known as the "1,800-foot level," which is in reality 1,839 feet above sea level, or 731 feet above the present level of Lake Chelan. This bench can be traced down to and along the Columbia River, and up the Methow River until it reaches the corresponding level in that stream at the present time, and it is easily traceable on Squaw Creek and numerous other small streams. When the water stood at that level the waters of Lake Chelan, the Columbia, the Methow, and some of the tributary streams of the latter were united in a large lake, while the present Antoine Coulée formed a narrow strait between Chelan and the Methow, the summit of its present eastern wall forming a narrow, rocky island. Later on, when the Columbia, farther down its course, had deepened its bed by erosion, and so lowered the level of this ancient lake, the Chelan watershed for a time found an outlet through the present Knapp Coulée, thus forming the next prominent bench, at 1,561 feet. At a still more recent period the Chelan River, 3½ miles long, came into existence, and, as it lowered the lake level by alternate periods of rapid erosion and temporary stationary halts, numerous benches between that of 1,561 feet and the present lake level were formed, none of them, however, so well defined as the two just mentioned. A similar series of benches may be seen along the Methow, caused by alternate eroding and stationary periods on that stream and the Columbia. That this process is still going on in the Chelan Basin can scarcely be questioned, but owing to reduced precipitation in the region, with consequent reduction in volume of water of the annual spring freshets, it is much slower and less noticeable, but I think none the less certain, than formerly.

Of the many Indian pictographs to be seen painted on the rocks on the shores of Lake Chelan, one in particular would, I think, go to show that there has been a lowering of the water level of the lake even in recent times. This is on the face of a perpendicular cliff on the west bank, near the head of the lake, and the upper part of the pictograph is fully 25 feet above the present level of the lake. The only other theory on which its presence on this spot can be explained is that the artist was lowered from above; but as the painting is a rather extensive one, I do not think such an explanation tenable in view of the primitive means at the command of the early red man. A lowering of, say, 10 feet in the Chelan River would leave a bench of 3 or 4 square miles of dry land about the foot of the present lake.

The best yellow pine (*Pinus ponderosa*) timber in the whole region is to be found growing on and about these benches, at elevations of from 1,200 to 3,500 feet.

The work of glaciation is amply evidenced throughout the whole region. Many of the rocks in the Stehekin Valley, and particularly those on the shores of Lake Chelan, are as distinctly grooved and burinated as though the ice with its stone chisels had passed over them within the present century, while the rounded appearance of the hills at all elevations from 1,108 to 5,500 feet is characteristic of the region from the foot of Lake Chelan to the headwaters of the Methow. Chelan Butte—3,722 feet—may be taken as a type of this rounding. It is only near the summits of the peaks, about the talus slopes, and along the crest lines of ridges and divides, that the rocks still remain sharp and angular.

One aiguille to the west of Horseshoe Basin, near a mining prospect known as the "Blue Devil," can not, I think, be surpassed anywhere for acuteness of angle.

The surface rock of the region is chiefly granite, or granitoid, with occasional exposures of calcareous rock about Lake Chelan, mica on Chelan Butte, some red porphyry and conglomerate on the Methow, a considerable eruption of basalt on the north bank of Early Winters Creek, and an outcropping of lignite on the Twisp, while large, crumbling bowlders of basalt are to be found near the foot of Lake Chelan and along the Columbia, where they were left by the retreating ice.

Alkali and alkali-bearing rocks are rather scarce, only two places with such indications being observed on the trip, a small alkaline lakelet (partially dry in summer) on the east side of Lake Chelan, and a similar one near the Twisp. This is well borne out by the fact that not a single specimen of the true greasewood, *Sarcobatus vermiculatus* (a shrub well known to favor alkaline soils) was collected during the season.

Marshes are rare in this region, only two being seen, one on the Entiatqua divide and another on the Methow divide, both above 5,000 feet altitude. Some diminishing lakelets and one or two dried-up lake beds are to be found near the Twisp.

CLIMATE.

The climate of this portion of the reserve is a very dry one, even for the country east of the Cascade Range, being, in fact, drier than that of the sections farther east, north, or south. A record kept by the Weather Bureau on Lake Chelan for five years gives a mean annual temperature of 49.1° and a precipitation of only 12.23 inches per annum, of which 5.1 inches is in the form of snow, the mean annual snowfall for five years being 51.4 inches. At Spokane, about 100 miles to the east, the mean annual temperature is 48.5° and the precipitation 18.12 inches.

As the above record was kept at an elevation of 1,150 feet, and some 85 miles distant from Cascade Pass, the annual precipitation is, of course, greatly increased as a higher altitude is reached and the summit of the divide approached; thus, while the average greatest depth of snow in midwinter at the foot of Lake Chelan is 36 inches, at Stehekin (head of Lake Chelan), 1,150 feet elevation, it is 60 inches, and at Bridge Creek, 2,204 feet elevation and 15 miles nearer the divide, it is 96 inches. In Horseshoe Basin and the northern section of the reserve the precipitation is still greater.

This is well exemplified by the vegetation, particularly the grasses and trees, the more or less alpine among the latter being found growing at a much lower elevation in the valley of the Stehekin than anywhere else about Lake Chelan, while such moisture-loving shrubs as *Echinopanax horridum* and *Viburnum pauciflorum* are to be found only in moist, more or less elevated ravines and valleys, such as those of Railroad Creek, Stehekin River, Copper Creek, and about the headwaters of Bridge Creek. But in proof of the fact that the whole region is still much drier than the country west of the Cascade Range, not a single specimen of the salal (*Gaultheria shallon*), a noted moisture-loving shrub, was seen or collected on the trip.

July and August are the driest months of the year, averaging only 0.18 inch—less than one-fifth of an inch—per month; January and December, the months of the greatest precipitation, averaging 1.91 inches per month. August is the hottest month, January the coldest.

The hottest day on record was August 17, 1897, 99° F.; the coldest, January 31, 1893, -18° F. The prevailing direction of the wind is west and southwest, except in January and December, when it is east and northeast.

The first snow at lake level (1,108 feet) usually occurs about the middle of November, while at 5,100 feet elevation in the Methow Range the first snow of this season was experienced on September 2. On October 26 there was 18 inches of freshly fallen snow in War Creek Pass (6,760 feet), with the snow line at 3,650 feet on the east or Twisp side and at 4,650 on the Chelan or west side of the pass.

The combined effect of the sun and chinook winds in causing the early disappearance of the snow from the west and southwest sides of the slopes and divides in spring, leaving them comparatively dry and arid in summer, is so great that it is not uncommon to find the east and northeast sides of some slopes and hillsides fairly well timbered with yellow pine and red fir, while the west and southwest sides are comparatively treeless.

The first frost of the season at lake level occurs between the first and the middle of October, usually occurring about ten days earlier at the head than at the foot of Lake Chelan.

At an altitude of 6,000 feet and upward frost is liable to occur under favorable conditions on any clear night, even in midsummer. During the trip to the headwaters of Twenty-five Mile Creek, August 9 to 14, we camped for some days at an altitude of 6,169 feet, and frost occurred on the nights of August 11, 12, and 13; while the minimum temperature on the corresponding nights at 1,150 feet was 57°, 56°, and 57° F., respectively. Notwithstanding this, many of the alpine and subalpine plants were to be seen in full bloom around camp without incurring the least apparent injury from this low temperature.

Along the canyon of Copper Creek at an elevation of 5,150 feet, on October 19, in spots entirely sheltered from the sunlight, ice 2 inches thick was observed on the creek, while in early morning the moist ground along the banks was frozen hard enough in some places to bear pack horses. The temperature at 7 p. m. on that date was 23° F.

SOIL.

The soil of this region is in general a powdery loam, sand and sandy loam being found only along some of the stream banks and in very limited quantity. Alkaline soil and alkaline deposits are rarer still, being observed in only two places. This is fully corroborated by the vegetation, which is lacking in most of the alkali-loving plants and shrubs. No clay soil whatever was observed on the trip.

The depth of the soil is very limited in all parts of the reserve, the rocks jutting out at all elevations from the lake level to the summits of the divides, and the soil rarely exceeding a foot in depth anywhere except in the alluvial deposits.

Owing to the repeated forest fires, which have devastated the region, humus is scarce, but where it occurs the soil is proportionately fertile. Wherever cultivated the soil has been found very fertile, the chief need being sufficient moisture. The old water levels or benches, probably because somewhat level, thus retaining longer the moisture from the accumulated snows of winter, are remarkably fertile—the case not this is only in the few isolated spots cultivated, but in the forest growth of these benches, where the yellow pine (*Pinus ponderosa*) is to be found at its best, both in quality and in quantity.

Alluvial deposits are rather limited, the rapid descent and high sloping banks of most of the streams precluding the formation of such deposits. The Stehekin River for about 6 or 7 miles from the mouth probably furnishes the best example in this portion of the reserve, the soil about the mouth being very fertile and, with one exception, growing the best hay seen during the season.

A few dried-up lake beds were observed on the Methow near its confluence with the Twisp. Treeless, except about the margins, where a few willows and occasional alders are to be found, these spots furnish at once the only black mucky soil and the most fertile tracts of land seen in the reserve, and produce the finest hay and grain, as well as garden vegetables. It is needless to add that these tracts were all taken up before the formation of the reserve.

AGRICULTURE.

Apart from the few holdings already taken up, the amount of land fit for agriculture in this portion of the reserve is almost nil. It is my judgment that there is not a single tract of 40 acres or more in extent in one piece suitable for agriculture that has not already been filed upon, and any tracts that would hereafter be filed upon under future concessionary legislation would undoubtedly be with other objects in view than those of pure agriculture.

A small area about the shores and old water levels of Lake Chelan, a narrow strip in the valley of the Stehekin, and a few tracts along the Twisp and in the Methow Valley constitute the very limited and only real agricultural land in the whole region. All of this land has already been filed upon, some of it long prior to the setting aside of the reserve.

Nearly all of the settlers who have thus taken up land are still obliged to have recourse to irrigation wherever possible, and nearly all of the small streams in the vicinity of these tracts are utilized when feasible, such as Twenty-five Mile Creek, Rainbow Creek, etc., near Lake Chelan, and Wolf Creek and other streams on the Methow and Twisp.

In some instances, such as Wolf Creek, the whole stream, although of considerable volume, is diverted for this purpose, leaving the mouth of the original stream bed dry, except during the early spring freshets.

In proof of the fact that some even of the so-called agricultural tracts which have been filed or settled upon are unsuitable for agriculture, one has but to observe the abandoned cabins to be found here and there, in order to become convinced that many of them are not adapted for this purpose.

GRAZING.

The grazing possibilities of this portion of the reserve are somewhat greater than would be anticipated in so dry a climate. The limited precipitation, except in the moist ravines and canyons, prevents the prolific growth of underbrush in the woods and forest, but is yet sufficiently great to insure a fair supply of the various grasses. In early spring the grasses are abundant and nutritious from the lake level to the foot of the lodgepole-pine belt—say, from 1,100 to 3,000 or 3,500 feet. In this lower zone the prevailing trees are yellow pine and red fir. Although it is quite true that about pine trees in general, and this one in particular, there is usually a small circle almost entirely devoid of grass, owing to the shade and the presence of a carpet of decaying pine needles, which destroys the grass on these spots, the forest in this zone is so open that there is ample space in which the grasses flourish luxuriantly. In this lower zone, therefore, the grazing is good for cattle and horses from spring till early summer, when the grasses begin to wither from lack of moisture.

By this time in the next zone above—that of the lodgepole pine, from about 3,000 to 5,500 feet—the grasses, though not so luxuriant as in the zone either above or below it, owing to the denser tree growth, are yet fairly abundant and furnish good summer grazing. The dense growth, though apparently inimical to the growth of the grasses, is in reality very beneficial to them.

The abundant forest litter to be found in this zone enriches the soil, and the shade furnished by the close growth of the trees, by retarding the melting of the snows, acts as a conservator of the water supply and thus insures moisture during the dry season, both for the grasses growing within its own limits and, to a greater or less extent, for those of the zone below.

In late summer and early autumn the whole region from the upper limits of the lodgepole-pine belt to the timber line, a range of about 2,000 feet in altitude, supplies grazing until the snow compels stock to again seek lower levels. In this upper zone grazing is, of course, scanty about the ridges and crest lines of the divides, but on the moist slopes and in the open glades and ravines the grasses, though short, are quite nutritious.

On October 22, at 5,400 feet elevation on Rattlesnake Creek, although the ground was covered with 5 inches of freshly fallen snow, the grasses were still succulent, and our pack animals found very good grazing for so late a date.

The grazing of sheep in such a region as this is much to be deplored and should be prohibited so far as possible. These animals crop the grass so closely that no other stock, with the possible exception of goats, can follow in a tract over which they have grazed and find enough to subsist on, and the roots of the grass are left so exposed that in the dry summers of this region much of it is destroyed. On the hill-sides and mountain slopes the effects are still worse. There, not only are the grasses cropped as closely as if devoured by locusts, but the sharp hoofs of the animals so trample the steep slopes that it takes years for a tract over which they have grazed to recover its original capacity to support other stock.

I do not apprehend any direct injury to a forest from the grazing of sheep, as they do not eat the conifers, and the amount of young coniferous saplings trampled by them is not, I think, of material consequence; but a slope over which they have grazed and trampled is much more liable to serious erosion by the water of the melting snows of the following spring than during years from the operation of natural causes. This, however, is but a trifling injury compared with the irreparable damage resulting to the forests from the fires which follow the sheep herder and his omnivorous band as constantly as foam follows in the wake of a steamer at full speed.

During the trip to the head of Twenty-five Mile Creek in August it was my privilege to traverse a tract of lodgepole pine (*P. murrayana*) and subalpine fir (*Abies lasiocarpa*) some square miles in extent on which a band of sheep had recently grazed. Such a picture of forest desolation I have seldom, if ever, seen. Scarcely a living tree was left, as both these species succumb readily to the effects of fire. Many of the pines, which have more shallow roots and are taller than the fir, had been so undermined by the burning of the dry humus about their roots that they had fallen, while the young and more succulent saplings had been scorched on one side and bent over like hoop poles. Scarcely a blade of grass was to be seen in the burnt district, the only vegetation that survived the fiery ordeal being one or two species of lupines, a sandwort (*Arenaria capillaris*), and a Gayophytum (*G. ramosissimum*). A few smoldering logs bore evidence to the recent date of the fire, and it is safe to say that the forest will not recover from the havoc wrought in less than a generation.

In early spring stock will readily eat the foliage and young shoots of the rabbit-brush (*Kunzia tridentata*, locally but erroneously called "greasewood"), and are quite fond of the two willows, *Salix lasiandra lancifolia* and *S. longifolia*, besides many other deciduous shrubs. In autumn, when the grass has become dry and scanty, they again turn with a relish to the willows, and are particularly fond of the flowering heads of the two Bigelovias, *B. douglasii stenophylla* and *B. douglasii tortifolia*, both of which are fall bloomers. They are also very fond of an *Aplopappus*. The local thistle (*Cnicus edulis*) is a special favorite with them: and in early autumn, when ponds and streams are partly dry, there is a considerable growth of horsetail (*Equisetum* *arvense?*) on the moist banks, that is eaten with avidity by both horses and cattle.

DRAINAGE SYSTEM.

Although the eastern portion of the reserve does not at any point impinge upon the Columbia River, the ultimate drainage of the whole region is into that stream.

The two principal drainage basins are Lake Chelan, with its chief tributary, the Stehekin, in the west, and the Methow River, with its many tributaries, in the east.

In the southwest corner, between the main divide of the Cascades and the Entiatqua Range, the drainage is through the various forks of White River and the Chiwahwah into the Wenache and thence into the Columbia. A little farther to the east in the same section, and between the Entiatqua and Chelan divides, the drainage is through Mad River and the headwaters of the Entiatqua, and thence via the latter river into the Columbia.

This southwest basin is quite limited in extent, its whole area not exceeding 360 square miles. The floor of the basin is about 3,500 to 4,000 feet in altitude, and this, combined with its proximity to the summit of the Cascade Range, causes an increased annual precipitation and consequent erosion. The result is a very steep slope in the banks of these streams in proportion to their volume.

The chief tributaries of Lake Chelan on the east are Mitchell Creek, Prince Creek, and Fish Creek, and on the west, Twenty-five Mile Creek, Dumpke Creek, and Railroad Creek. The main source is the Stehekin River on the north. This stream, with its tributaries, Agnes Creek and Bridge Creek, has a drainage area of about 280 square miles, and is included in that of the Lake Chelan Basin. Its valley ranges in altitude from 1,108 feet at the mouth to 3,130 feet at the entrance to Horseshoe Basin, the mean level being about 2,200 feet, the elevation at the confluence of Bridge Creek with the Stehekin. This valley has a greater annual precipitation than any other section of equal area in the eastern portion of the reserve.

The drainage basin of Lake Chelan proper ranges in altitude from 1,108 feet at lake level to about 6,500 feet at the crest line of the divides, the bulk of the area being between 2,000 and 3,500 feet. The whole basin has a drainage area within the limits of the reserve, including the area of the Stehekin above mentioned, of 980 square miles. Its drainage area outside of the reserve would probably amount to 100 square miles additional. The best yellow-pine timber in the reserve is to be found in this basin. The lake itself is navigable for its entire length of 55 miles, two small steamers plying on it. This is the only navigation in this portion of the reserve at the present time.

Methow River is the largest stream in the eastern portion of the reserve, its total length from its most northerly source to its confluence with the Columbia, at Ives, being about 100 miles. It is not navigable, and owing to its rapid descent its erosive powers are considerable. This is well borne out by the numerous benches (indicating former higher levels) to be seen along its course, the steep slope of its banks in many places, and the rounded appearance of the hills in the lower part of its valley. Its width at the mouth is about 125 feet, while in some parts of its course, notably between Ventura and the mouth of Early Winters Creek, it is over 200 feet wide. In summer and early autumn, although the volume of water is yet considerable, it disappears in some places underneath its bed of bowlders and gravel, to burst forth again at a lower level farther down its course. The most notable of these disappearances takes place immediately after it is joined by Lost River, a stream 50 feet wide and about 12 inches deep at the time of examination, in October.

There are several indications about the lower part of the valley that at a former period this whole region had a much greater annual precipitation than at present. The chief tributaries of the Methow are the Twisp River and Early Winters Creek on the west side, and Chewack Creek (sometimes called the north fork of the Methow), Goat Creek, Lost River, Robinson Creek, and Rattlesnake Creek on the east and north. Of these the Twisp is the largest and most important and drains a considerable area, including some agricultural land near its mouth and a well-forested tract about its headwaters.

Almost the whole basin of the Methow is included in the reserve, the drainage area of the portion included being a little less than that of the Lake Chelan Basin and amounting to about 940 square miles. The floor of the basin ranges in altitude from about 1,200 feet, where the Methow, near its mouth, leaves the reserve, to 2,700 feet at its confluence with Lost River. Methow Valley contains the best agricultural land to be found in this portion of the reserve, and the bench land along its course produces a quantity of yellow pine suitable for lumber purposes.

In the northern section the drainage is by Pasayton Creek and Naisnuloh River through British Columbia into the Similkameen, and thence through Okanogan River into the Columbia. The drainage area of this basin is about 420 square miles. The annual precipitation is greater than farther south in the reserve, but owing to its great altitude the region is so alpine in character that the forest growth, though abundant, is too scrubby and stunted to produce merchantable timber.

UTILIZATION OF THE WATER SUPPLY.

The annual precipitation of this portion of the reserve, particularly the southern section, is very limited, being only 12.23 inches, of which 8.85 inches, or a little over 72 per cent, falls during the six months from November to April, thus leaving only 3.38 inches—0.56 inch per month—to be distributed over the remaining six months from May to October. Irrigation is consequently almost a necessity for even such limited agriculture as there is here. As a result, wherever there is a small tract suitable for agriculture the creeks and runs in its vicinity are used for irrigation. Twenty-five Mile Creek, Rainbow Creek, and a few other small streams are utilized very successfully for this purpose about Lake Chelan.

On the Methow at the time of my visit the whole volume of Wolf Creek was diverted for the irrigation of adjoining ranches. Elsewhere along the river some smaller creeks were being wholly or partially utilized for the same purpose. Along Twisp River a few of the smaller watercourses were likewise being used with very gratifying results. In fact, while a few fruits and some vegetables may be raised, the successful raising of cereals or timothy in this region without irrigation is out of the question.

I found that the water of Squaw Creek, a tributary of the Methow, had been used for some years for the reduction of ores in arrastres, but at the time of my visit these were not in operation, owing to the reduced price of silver.

In all I found only three sawmills taking their supply of logs from the reserve, all of them operated by steam power and using such water only as was required for boiler purposes. On the Methow, however, I found a flume still in use, where one of these sawmills had until recently made use of a considerable stream of water for some purpose; but this mill had been removed to the Twisp some months before my visit.

There are numerous waterfalls and unused water powers in this portion of the reserve which can be readily and successfully utilized whenever the necessity for ~~its~~ their employment arises.

VEGETATION

The vegetation of the eastern portion of reserve may be divided into four zones or belts, in ascending order as follows:

1. The yellow-pine zone, 1,100 to 3,000 feet.
2. The lodgepole-pine zone, 3,000 to 5,200 feet.
3. The subalpine-fir zone, 5,200 to 6,000 feet.
4. The white-bark-pine zone, 6,000 to 7,500 feet.

It should not be inferred that these trees are strictly confined to the limitations given. Such an inference would be misleading, as the trees frequently overlap. The yellow pine is sometimes found growing at as high an altitude as 5,700 feet; the lodgepole pine as high as the lower limits of the white-bark pine, and the subalpine fir at slightly higher and sometimes at lower altitudes than those given. In the main, however, the limitations given will be found to apply fairly well to the whole region with the exception of the moist valleys and canyons and the vicinity of the passes on the main divide of the Cascade Range, where the extra moisture will be found to produce certain modifications. In these moist valleys and canyons some trees will be found that do not occur outside of these locations, and all the alpine and subalpine trees will be found growing at lower elevations than elsewhere in the reserve.

YELLOW-PINE ZONE.

This zone extends from 1,100 to 3,000 feet, and with a few exceptions includes all the merchantable timber to be found in this region. As the name indicates, the dominant tree in this zone is *Pinus ponderosa*. This tree, it is well known, avoids moist climates or locations, and consequently finds in this region a favorable habitat. It is to be found at its best on the benches in this zone, where it attains a height of 65 to 90 feet, with a diameter ranging from 18 to 52 inches, including bark. Its growth is never dense, and on the dry hillsides of this region it is quite scattering, but constitutes about 85 per cent of the trees growing within the limitations given.

The next tree in importance here is *Pseudotsuga* ~~*taxifolia*~~ mucronata, which amounts to about 12 per cent of the tree growth of this zone, thus leaving but 3 per cent to be made up by a few others. It is not at home in this dry situation, and falls far short, both in size and in quality, of its growth west of the range.

Thuja plicata occurs very sparingly in this zone, being found only along moist ravines, but the quality is good. Its favorite habitat here is in the moist valleys and canyons.

Juniperus ~~*virginiana*~~ scopulorum is here almost entirely confined to lake level, where it is so twisted and gnarled by the winds as to be useless for economic purposes. Only one tree was found over 25 feet in height, and not a single specimen was seen above 2,000 feet elevation. The other trees in this zone are:

Salix lasiandra lancifolia.	Cratægus ~~sp. (No. 689).~~ macracantha
S. longifolia.	Acer macrophyllum.
Populus trichocarpa.	A. glabrum.
P. tremuloides.	Cornus nuttallii.

Of these the most valuable is *Acer macrophyllum*, but it is only in moist ravines and river bottoms that it attains merchantable size.

This zone includes nearly all the shrubs of any consequence in this region. Alders are common in all the moist ravines, but are by no means confined to this zone and may be found almost up to timber line. The two cherries, *Prunus emarginata* and *P. douglasii*, bear fruit here abundantly, but are rarely to be found above this zone. The fruit of *P. douglasii* only is edible.

The dominant shrubs and undershrubs may be enumerated as follows:

Berberis aquifolium.	Acer glabrum.
Philadelphus lewisii.	Ceanothus velutinus.
Ribes cerum ?. e	Cornus baileyi.
Holodiscus ariæfolius.	Arctostaphylos uva-ursi.
Rubus nutkanus.	Sambucus glauca.
Kunzia tridentata.	Symphoricarpos rotundifolius.
Amelanchier florida.	Bigelovia douglasii stenophylla ?.
Rhus glabra.	B. douglasii tortifolia.
Pachystima myrsinites.	Artemisia ludoviciana.

Apart from the various grasses and ferns, the dominant plants in this zone are:

Selaginella rupestris.	Mentzelia laevicaulis.
Zygadenus venenosus.	Pentstemon richardsonii.
Eriogonam niveum.	Balsamorrhiza sagittata.
E. elatum.	Anaphalis margaritacea.
Clematis ligusticifolia.	Achillea millefolium.
Lotus americana.	Coreopsis atkinsoniana.
Euphorbia serpyllifolia.	Chaenactis douglasii.

THE LODGEPOLE-PINE ZONE.

The limits of this zone are from 3,000 to 5,200 feet in altitude, and include the densest growth in this region outside of the moist ravines and canyons. The principal tree to be found here is, of course, *Pinus murrayana*. This tree is more closely confined to the limits of the zone than the yellow pine, and is not found at lower elevations, except in moist canyons. In some few localities it ranges upward to the lower limits of *P. albicaulis*. Its growth is so dense that very few shrubs are to be found in this zone. Toward the upper boundary it is largely intermingled with *Abies lasiocarpa* and *Picea engelmanni* and small quantities of *Pinus ponderosa* and *Pseudotsuga taxifolia*, but its dense growth lower down prevents the latter trees from getting a foothold in the central portion of this zone. Owing to its dense growth and the consequent shade afforded by it, this tree is well adapted for the conservation of the water supply, and large patches of the winter snow may be found under its protecting shadows as late as July. On the other hand, its shallow roots, tall, weak stems, and exposure to the winds at these high altitudes result in large quantities of fallen timber, which leave the trees an easy prey to forest fires, which are only too frequent in this region. This is the most vulnerable of the four zones and should be protected wherever possible.

Shrubs and undershrubs here are few, compared with the zone below, the principal among them being:

Alnus rubra.	Pachystima myrsinites.
Berberis nervosa.	Ceanothus velutinus.
Ribes viscosissimum.	Arctostaphylos uva-ursi.
Spiraea lucida.	Ledum glandulosum.
Aruncus aruncus.	

Among the plants of this zone may be noticed a few lupines:

Linnaea borealis.	Castilleja linariaefolia.
Anaphalis margaritacea.	Achillea millefolium.
Hieracium albiflorum.	Hieracium cynoglossoides.

About the upper limits there are also a few arnicas and senecios.

THE SUBALPINE-FIR ZONE.

This zone is not so well defined as the last, but it may be said to extend from 5,200 to 6,000 feet. The dominant tree here is *Abies lasiocarpa*, which appears to obtain a foothold on many of the subalpine grassy slopes long before they are occupied by any other tree. It is a small tree and is easily destroyed by fire, but it is much more firmly rooted than *Pinus murrayana*, and is therefore useful as a soil binder on the steep slopes.

The next tree in amount here is *Picea engelmanni*. It has a greater altitudinal range than the preceding, being found both above and below it. It is also of much greater economic value, as it is a large tree, and makes very serviceable lumber. The greatest drawback here is its inaccessibility.

Abies amabilis belongs to this zone and ranks next, both in quantity and in value, to *P. engelmanni*. It is a much larger tree than *A. lasiocarpa* and is equally vulnerable to the attacks of fire, but prefers the moist valleys and canyons more than the latter.

The most noticeable shrubs and undershrubs in this zone are:

Pachystima myrsinites.	Arctostaphylos uva-ursi.
Ceanothus velutinus.	Ledum glandulosum.
Vaccinium parviflorum.	Artemisia ludoviciana.

The dominant plants found here are:

Eriogonum pyrolæfolium.	Valeriana sitchensis.
Cardamine lyallii.	Arnica alpina.
Sedum stenopetalum.	A. latifolia.
Saxifraga æstivalis.	A. parryi.
Parnassia fimbriata.	

THE WHITE-BARK-PINE ZONE.

This is the uppermost of the four zones, and ranges from 6,000 to 7,500 feet, or timber line. The dominant tree here is, of course, *Pinus albicaulis*. It is the most alpine of all the pines and quite valueless as timber, but as it persistently follows up the slopes and divides and obtains a foothold there, it performs an important work in the economy of nature by retarding the too early disappearance of the snow from these slopes, and, by making more or less forest litter, encourages the spread of other vegetation.

The second tree in importance in this zone is *Larix occidentalis*. This tree seldom grows on the exposed side of a pass or divide, but on the sheltered side can be found in this region up to 7,000 feet elevation. It is a much larger and finer tree than *P. albicaulis*, and in early autumn, when the first severe frosts have turned its foliage yellow, it is noticeable on the cliffs and mountain sides for miles.

The only other trees to be found in this zone are *Tsuga pattonii* v. hookeri and *Picea engelmanni*. The former is a small alpine tree, with a northern range hundreds of miles beyond that of the white-bark pine, and is usually found on exposed ridges and cliffs, much twisted and gnarled by the winds. In these situations it can frequently be found 12 inches in diameter and not exceeding 10 or 12 feet in height. It differs from the type in being smaller and more alpine and having great masses of small, erect, purple cones, those of the type being pendulous.

Chamæcyparis nootkatensis belongs in this zone, but in this region is not to be found outside of the moist canyons.

Juniperus nana, the most diminutive representative of the conifer family, is fairly common about rocky cliffs and the crest lines of the ridges and divides in this zone. It usually favors moist climates and localities, being a common shrub in the sphagnous marshes of Alaska, but in this region it appears quite at home in even the driest situations, and was found growing from lake level (1,108 feet) to timber line.

The few shrubs and undershrubs to be found here are more or less alpine in habit, such as:

Pachystima myrsinites.
Bryanthus empetriformis.
Cassiope mertensiana.
~~Azalea~~ Rhododendron albiflorum.
Ledum glandulosum.
Sambucus racemosus?.
Artemisia ludoviciana.

The first named, although properly belonging to the lowest zone, can be found growing here almost to timber line.

The principal plants of this zone are:

Eriogonum umbellatum.
Oreobroma columbiana.
Arenaria capillaris.
Sedum stenopetalum.
S. divergens.
Saxifraga tolmæi.
Polemonium pulchellum.
Pentstemon menziesii.
P. scouleri.
P. procerus.
Macronema suffruticosum.
Erigeron ~~sp. (No. 580)~~. leibergii.

MOIST VALLEYS AND CANYONS.

The moist valleys and canyons here, of which those of Stehekin River and Early Winters Creek may be taken as typical, have a more or less local flora of their own, as compared with the rest of the reserve.

Trees occurring in them and not specially enumerated in the above-mentioned zones are briefly described below:

Pinus monticola is a tall, graceful tree of considerable economic value as lumber. It was not seen outside of the moist valleys, and ranges here from 1,150 to 4,700 feet.

Tsuga mertensiana is fairly common in the valleys of the Stehekin River and Early Winters Creek, and ranges from 2,100 to 4,700 feet elevation.

Tsuga pattonii (type) is a fine subalpine tree occurring in all the moist valleys close to the passes in the main divide of the Cascade Range. Its extreme altitudinal range here is from 2,170 to 5,800 feet.

Tsuga pattonii var. *hookeri?* Lemmon, a tree somewhat resembling the last but much more alpine in size and habit, ranges from 5,500 to 6,400 feet elevation.

Abies amabilis is fairly common here, and its altitudinal range is from 1,800 feet on the Stehekin to 5,500 feet on Early Winters Creek.

Thuja plicata, a tree quite rare outside of the moist valleys, is here fairly common, of large size, and of considerable economic value. It ranges in altitude from 1,100 to 4,700 feet.

Chamæcyparis nootkatensis is fairly common on the Stehekin and its tributaries, but was not observed elsewhere. Its range here is from 2,100 to 5,500 feet elevation.

Taxus brevifolia is rare, and was seen only on the Stehekin and its tributaries, where it ranges from 3,500 to 5,100 feet elevation.

Populus trichocarpa and *Acer macrophyllum* were found in the Stehekin Valley, far surpassing in size the specimens seen anywhere else in the reserve.

Acer circinatum was seen only on the Stehekin.

A few of the shrubs and undershrubs already enumerated were found here, and many not elsewhere seen, such as:

Berberis nervosa.
Spiræa arbuscula.
S. menziesii.
Rubus spectabilis.
Sorbus occidentale.
Lepargyræa argentea.
Echinopanax horridum.
Vaccinium sp.
Kalmia glauca microphylla.
Menziesia ferruginea.
Viburnum pauciflorum.
Lonicera involucrata.

The characteristic plants of these valleys are:

Clintonia uniflora.
Goodyera menziesii.
Oxyria digyna.
Aconitum columbianum.
Actæa rubra.
Aquilegia formosa.
Bikukulla formosa.
Saxifraga bronchialis.
Washingtonia occidentale?.
Chimaphila umbellata.
Gentiana sp.
Mimulus lewisii.
Mimulus moschatus.
Castilleja parviflora.
Pentstemon menziesii.
Veronica alpina.
Aster peregrinus.
A. foliaceus.
Luina hypoleuca.

TREES OF THE REGION.

PINUS MONTICOLA Dougl. (Mountain white pine.)

This tall, graceful tree is comparatively limited in quantity in this portion of the reserve, being strictly confined to the moist valleys, where it is thus to a great extent enabled to escape damage by fire, to which it is much more liable than *P. ponderosa* or *Pseudotsuga taxifolia*, owing to its thinner bark.

It occurs on Railroad Creek, Agnes Creek, Stehekin and Twisp rivers, and Early Winters Creek, ranging in altitude from 1,150 feet on the Stehekin to 4,700 feet on Early Winters Creek. The best grove seen was on Early Winters Creek, where it would probably average 10,000 feet per acre. Even here it still falls short of the height and size it attains in other parts of the State. It ranges in size here from 20 to 42 inches in diameter and from 110 to 160 feet in height.

Though its sapwood is much greater in proportion to total diameter than that of *Pinus ponderosa*, it makes better lumber, as it is far less liable to warp in use or on drying, and it is not yet used for lumber purposes here solely because it is more inaccessible. The wood contains much less pitch than that of *P. ponderosa*, and the lumber does not lose as much weight in drying as the latter. Notwithstanding the small quantity of pitch contained, the logs when in the water have the further advantage of not becoming waterlogged, a fault to which those of *P. ponderosa* are peculiarly liable. As fuel, however, it is inferior to the latter.

It is a remarkably healthy tree, not a single dead specimen, except a few that had been killed by fire, being seen on the trip, and all the mature trees seen were well loaded with cones. The number of young trees seen bear evidence that it is being well propagated, the only requisite for its greater distribution being sufficient moisture.

The tall stems with the crowns elevated above the surrounding forest growth, the mass of long typical cones of the mature trees, and the bluish green color of the foliage of the young trees and saplings, tend to make the tree so noticeable that one is liable to overestimate its quantity in the forest here.

PINUS ALBICAULIS Engelm. (White-bark pine.)

This hardy alpine tree is quite common at all the higher elevations in this region, and is apparently as much at home in the humid atmosphere of the passes as on the dry crest lines east of Lake Chelan. The lowest altitude at which it was observed on our trip was at 4,600 feet, on Early Winters Creek, from which limit it can be found ranging upward at all elevations to 7,500 feet, or timber line.

The tallest specimens seen did not exceed 40 feet in height, while the diameter ranged from 12 to 24 inches, with an occasional veteran of 28 to 30 inches. The diameter is no index to the height, as one of the largest seen was on a wind-swept ridge and did not exceed 20 feet in height.

The tree is of very slow growth and slow propagation, but few young trees or saplings were seen, and only a limited number of the trees seen bore cones, while such cones as were found had in almost every instance been visited by Clark's crow (*Nucifraga columbiana*) and the seeds dexterously picked out. The best specimens of the tree seen were in the vicinity of Slate Pass and Windy Pass, between 6,000 and 6,800 feet in elevation. It is of no economic value, but its alpine nature enables it to encroach steadily up the steep slopes almost to snow line, where its long, firm roots act as soil binders and its shelter offers protection for the advent of other vegetation. Its wood is close grained and resinous, and it is thus enabled to resist decay for a long period, when felled or uprooted.

PINUS PONDEROSA Dougl. (Yellow pine; Piskwans name, Kuh-chin.)

This is preeminently the most useful tree in this portion of the reserve, being used not only for lumber but for fuel, building purposes, and various other economic uses. It ranges in altitude from 1,100 feet on Lake Chelan to fully 6,000 feet above the head of Poison Creek and in the Chelan Range, but it is found at its best for lumber purposes on the benches between 1,500 and 3,000 feet. It is a lover of dry climates and dry situations, being ~~strictly~~ mostly confined to the east side of the Cascade Range, and is not at home even in such moderately moist localities as the valley of the Stehekin or Early Winters Creek, where it is to be found only in very limited quantities. Its usual height in this region is from 65 to 90 feet, and in favorable situations trees can be found 110 feet in height; the diameter ranges from 18 to 52 inches. Among the specimens measured may be mentioned one on Lake Chelan: Diameter at stump height, $20\frac{3}{4}$ inches; diameter of wood, $17\frac{1}{4}$ inches; height of tree, 67 feet; age, 110 years. And one on Squaw Creek: Diameter at stump height, $52\frac{5}{8}$ inches; diameter of wood, $47\frac{1}{4}$ inches; height of tree, 91 feet; age, 411 years.

When young it is a very rapid grower and when mature its resistance to damage by fire is very great, more than 50 per cent of the mature trees seen here showing evidence of having escaped from one or more forest fires without serious injury. For these reasons the tree is a valuable one in this dry region.

Fully 90 per cent of the lumber used here is supplied by this tree. This is owing solely to its accessibility, as the quality is not equal to that of either the mountain white pine or the Engelmann spruce. The lumber from it is very much inclined to warp when sun or air dried, but when kiln dried is found to be very much improved.

Formerly there were three sawmills taking their supply of logs from this portion of the reserve, one on Lake Chelan, one on Methow River, and one on Squaw Creek; but at the time of my examination the last mentioned had been taken away from the reserve altogether and the one on the Methow had been removed to the Twisp, thus leaving only two in operation, both on a very limited scale. The logs cut here average only 2 to a tree, and 7 logs to 1,000 feet of lumber. This tree is very healthy and produces large quantities of cones, but for some reason does not propagate very abundantly here.

Apart from those killed by fire, only a few dead trees were seen, chiefly about the head of Poison Creek; very few were found to be infested with Arceuthobium, and none afflicted with fasciation were observed.

PINUS MURRAYANA Balf. (Lodgepole pine.)

The lodgepole, or tamarack pine, as it is sometimes called, is capable of enduring much more humidity than the yellow pine, and consequently is found to be as much at home in the moist valleys as on the dry slopes and hillsides. It is unsuitable for lumber, but makes excellent fuel, and is used to some extent locally for building purposes, fencing, etc., for which it is better adapted than the yellow pine. Its general altitudinal range in this region is from 3,000 to 5,200 feet, but I have observed it at 2,100 feet on the Stehekin and as high as 5,900 feet in the Chelan Range. When found growing near its upper limits, particularly in the less fertile spots, the foliage is short and frequently has a whorled appearance, so that at a distance it bears some resemblance to a larix, thus giving rise to the common name tamarack pine, by which it is known in some localities.

It grows from 60 to 110 feet in height and ranges in diameter from 8 to 16 inches. The largest specimen observed on the trip was at 5,100 feet elevation, and measured 16¼ inches in diameter inside bark at stump height. It is a very slow grower; a sapling 33 inches in height was cut and found to be 26 years old; it had not yet borne cones, but had well-developed male flowers of this season's growth. A mature tree examined at the same locality was found to be 7¾ inches outside bark, 7¼ inches inside bark, 64 feet in height, and 115 years old. Owing to its shallow roots and tall, weak stems, the tree is peculiarly liable to be uprooted or broken by the high winds that usually prevail at these altitudes, and consequently in the forest where it is the principal tree there is much fallen and dead timber. This condition of affairs, together with its thin bark, makes it an easy prey to the forest fires, to which this region, with its dry climate, careless campers, and roving sheepmen, is liable. In fact, during the course of my examination I found that more than 50 per cent of all the dead timber observed was composed of this tree. Many dead and a few dying trees were also seen that showed no evidence of having been injured by fire, and the cause of their decay was not apparent. All the dead trees, and to a greater or less extent the dying ones, were thickly overgrown with a bright greenish-yellow lichen, which I take to be *Evernia vulpina;* but this is an effect rather than a cause of the decay. At about 5,000 feet altitude in several localities this tree was also found to be so badly infested with a small green aphis that all the vegetation beneath it was constantly bespattered with a transparent viscid substance exuded by the insects; but as the surrounding subalpine firs were similarly infested without any apparent injury, the decay of the lodgepole pine must be attributed to some other cause.

Larix occidentalis Nutt. (Western larch.)

This is the only deciduous conifer in this portion of the reserve, and differs somewhat, both in appearance and in habit, from the same tree farther south, where it frequently occurs in moist situations and at as low altitudes as 2,000 feet. It was not seen at all in the moist valleys, and was generally found to favor the passes and the sheltered sides of the crest lines and divides, where it ranges in altitude from 5,800 to 7,100 feet. The best grove seen was at about 6,700 feet elevation, near War Creek Pass. The tree ranges in height from 50 to 90 feet and in diameter from 10 to 25 inches. The mature tree has a rather thick grayish bark, and is well fruited with oval, mostly erect, persistent cones. The branches are mostly lateral, very brittle, and quite small in proportion to the size of the tree. The foliage changes color here with the first severe frosts, about October 1, and on October 20 I found about half still remaining on the trees, while on October 26 the surface of the snow was yellow with the foliage blown off by a recent storm. It is not used for lumber, but would make good fuel where accessible, owing to its hard wood and close grain.

PICEA ENGELMANNI Engelm. (Engelmann spruce.)

This tree requires much more moisture than the preceding, though I have found them growing together in one or two instances. It has also a much greater altitudinal range, being found from 2,100 feet elevation in the Stehekin Valley to 6,800 feet on the sheltered slopes of some of the ridges and divides. It generally avoids the wind-swept crest lines and passes, and is usually a robust, healthy tree, but in some localities, as on Early Winters Creek, I observed specimens affected with fasciation. The tree is well adapted by nature for propagation, being fully fruited with large quantities of cones, which are massed near the top. When young, the cones are erect and reddish purple in color, becoming pendent and fading to a light brown as they mature.

Near its upper limits the tree is quite stunted, the cones rather scanty, and a large percentage abortive. It is one of the finest trees in this region, ranging from 90 to 150 feet in height and from 18 inches to 4 feet in diameter, the largest specimen measured being 4 feet 5½ inches. The best grove seen was at 4,250 feet elevation, on Bridge Creek, where it would cut about 10,000 or 12,000 feet to the acre. Though not used here, it makes fair lumber and excellent fuel, but is very vulnerable to forest fires, the least injury about its base being fatal to it.

TSUGA MERTENSIANA (Bong.) Carr. (Western hemlock.)

The western hemlock is here confined entirely to the moist valleys, and occurs in limited quantities along the Stehekin River, Agnes Creek, and Early Winters Creek, ranging in altitude from 2,100 feet on the Stehekin to 4,700 feet on Early Winters Creek. It was not observed on Bridge Creek or on Twisp River. In comparison with the size it attains west of the Cascade Range, particularly near sea level, it is a small tree here, being from 50 to 75 feet high and from 10 to 25 inches in diameter. It is much superior to the eastern hemlock (*T. canadensis*) both in quality of wood and in the quantity of tannin contained in the bark, and makes very fair lumber. When thoroughly dry, it makes better fuel than any of the pines growing here.

TSUGA PATTONII (Jeff.) Coville. (Alpine hemlock.)

This hemlock is also confined to the moist valleys and the vicinity of the passes. It is the prevailing tree in Cascade Pass (5,421 feet) and is quite common about the headwaters of the Stehekin, where it attains a very fair size for this region, ranging from 50 to 90 feet in height and from 12 to 27 inches in diameter. The altitudinal range of the tree here is much greater than was expected, being not uncommon at 3,100 feet and ranging up to 5,800 feet; and a tree supposed to be of this species was observed as low as 2,100 feet elevation in the Stehekin Valley.

This tree is sometimes mistaken for the western hemlock, but close observation at once dispels such an error: the top of the sapling is erect, the cones are long, purple, and more or less massed about the top of the tree, and the mature tree has an unusually thick, roughly corrugated bark, while in the western hemlock the top of the sapling is generally drooping, the cones are small, oval, and brown in color and well distributed on the branches, and the matured tree has a comparatively thin bark.

The alpine hemlock is of slow growth; the wood is close grained and of fine texture and is quite suitable for lumber or fuel, but is not used for either purpose here on account of its inaccessibility.

The bark is grayish brown in color and quite noticeable in the forest owing to its thickness, which appears to increase toward the upper limits of the range of the tree. The general altitude of this region is favorable to the growth of the tree, but the amount of moisture, outside of the valleys and canyons, is insufficient.

TSUGA PATTONII var. HOOKERI? (Hooker's hemlock.)

Among the hardy alpine trees Hooker's hemlock stands preeminent, having a northern range far beyond that of even the white-bark pine. It is a small, dwarfed, and stunted tree compared with the type, and seldom exceeds 12 inches in diameter or 30 feet in height. It usually ranges in altitude here from 5,500 to 6,400 feet, but is occasionally found up to and beyond 7,000 feet, wherever it can find sufficient moisture. Though generally favoring the heads of moist valleys, it is sometimes to be found on the leeward sides of peaks and slopes where snowbanks of sufficient size have formed in winter to maintain an adequate supply of moisture during the rest of the year. It is in the latter situations that the tree reaches its highest altitude.

In addition to its smaller size and more alpine habit, it further differs from its nearest congener in having thinner bark and small, erect cones, all the other hemlocks having pendent cones. The tree is too small and inaccessible to have any economic value.

PSEUDOTSUGA mucronata ~~TAXIFOLIA~~ (Raf.) Sudw. (Red fir; Piskwaus name, Tsuh-kalp.)

Next to the yellow pine this is the most economically important tree in this region at the present time. It ranges in altitude from 1,100 to 6,000 feet, and forms about 12 per cent of the tree growth of the yellow-pine zone (1,100 to 3,000 feet), where it attains its best development, both in size and in quality, on the benches and in the sheltered ravines. It occurs only sparingly in the lodgepole-pine zone, particularly in all dense growths of that tree, but reappears again about its upper limits. Though a well-known lover of moisture, it is quite limited in quantity in the moist valleys and canyons, probably owing to low temperature.

It ranges in height here from 70 to 120 feet and in diameter from 20 to 50 inches. It grows very rapidly for the first one hundred and fifty years, but after that period gradually becomes of slower growth. The bark is very thick, exceeding even that of the yellow pine, and on this account the grown tree is enabled to withstand a forest fire in which the lodgepole pine, Engelmann spruce, or any of the firs would perish. Among the specimens measured, a tree at 5,510 feet elevation, 132 years old, gave a diameter at stump height of $18\frac{3}{4}$ inches inside and $21\frac{3}{4}$ outside bark, while one at 1,200 feet elevation, 244 years old, was 43 inches in diameter inside and 49 inches outside bark. About 10 per cent of the lumber used here is supplied by this tree, and its wood excels that of all others in this region for fuel. For some reason the tree is not so healthy here as west of the Cascade Range, fully 50 per cent of the grown trees being found to be affected with fasciation. About lake level it is rather stunted in growth and much twisted and gnarled by the winds, so that the benches and higher levels must be sought for trees suitable for lumber.

All the trees observed here bore cones abundantly, and all the cones examined were found to be well filled with seed. The tree bears cones at an earlier age than any other conifer. Among the saplings examined, one 12 years old had two well-developed cones of this season's growth. It would undoubtedly spread rapidly here if sufficient moisture were obtainable, as on a level spot only 20 feet square at 3,400 feet elevation 15 saplings were seen. In late autumn all the grouse killed were found to have their craws literally filled with the seeds of this tree, to the exclusion of almost every other kind of food.

ABIES LASIOCARPA (Hook.) Nutt. (Subalpine fir; Piskwaus name, Skwe-whe-alp.)

Outside of the moist valleys and canyons this tree is fairly well confined in altitudinal range to the moist slopes between 5,000 and 6,000 feet, the lack of moisture preventing it from finding a foothold on the dry crest lines and ridges above, and the dense growth of lodgepole pine, combined with lack of moisture, prohibiting its spread below. In the moist valleys, on the other hand, it has much more extended altitudinal limits, ranging from 2,150 feet on the Stehekin to about 7,000 feet in the vicinity of Slate Pass and Windy Pass. The tallest specimen seen, about 90 feet, was in a moist ravine about the head of Twentyfive Mile Creek, while on some of the wind-swept ridges it could be found less than 10 feet high, with branches spread out along the ground fully 10 feet on each side of the trunk. In diameter it ranges from about 8 to 18 inches. Though a decidedly alpine tree, its capacity for standing cold is not equal to the white-bark pine or Hooker's hemlock.

Owing to its thin bark the tree is very easily injured or killed by forest fires, as even a moderate degree of heat causes the bark to blister or separate from the trunk; but notwithstanding this, the wood makes very poor fuel, even when dry—burns slowly and gives very little heat.

This was the only conifer in the region with a scanty crop of cones this year. Unlike the red fir, which bears an average crop every year, this tree bears a large crop but once in three years, and being loaded with cones last year the grown trees were sparingly fruited this season and only the young trees which bore for the first time were well fruited. No economic use whatever is made of it in this region.

ABIES AMABILIS (Loud.) Forbes. (Lovely or amabilis fir.)

The regional range of this tree is much more limited here than that of the subalpine fir, but its altitudinal range is almost equal to that of the latter, being found from 1,800 feet on the Stehekin to 6,500 feet at the head of Rattlesnake Creek. It is also a much larger tree, ranging from 30 feet in alpine situations to 100 feet or more in moist ravines, with a diameter ranging from 12 to 25 inches. No groves wholly composed of this tree were seen, but it is to be found in scattering quantities along Stehekin River, Bridge Creek, Early Winters Creek, and Rattlesnake Creek, and about its upper limits it is always found mingled with its near congener, *A. lasiocarpa*.

Though the wood is straight grained and apparently suitable, it is not used for lumber, and it is comparatively worthless for fuel. The bark is thin, being only slightly thicker than that of the subalpine fir, and the tree is almost as easily injured by fire as the latter.

THUJA PLICATA Don. (Pacific red cedar or Pacific arbor vitæ; Pickwans name, "Suk-wum.")

This cedar, owing to its moisture-loving habit, is mostly confined to the moist valleys in this region, and outside occurs only in a few moist ravines; but wherever seen it was always healthy and thriving, whether a sapling or grown tree. It begins to bear when quite young, and all the grown trees were found to be well covered with cones. Though naturally inclined to grow in groves by itself, none were seen in this region, but the tree was observed in fair quantities mingled in the forest on Stehekin River, Bridge Creek, Early Winters Creek, and Twisp and Methow rivers. It ranges in altitude from 1,100 feet on the Stehekin to 4,700 feet on Early Winters Creek. In height it ranges from 50 to 100 feet and in diameter from 15 to 60 inches, the largest specimen measured being 4 feet 7½ inches inside and 4 feet 9½ inches outside bark at stump height. It grows slowly, the annual rings being so fine as to be difficult to count in most cases; but judging from the number of annual growths in some of the small trees, the large ones of this species are undoubtedly the oldest living trees in this region.

The bark is rather thin, but nevertheless the grown tree resists the effects of forest fires fairly well and can be found flourishing where both the firs have succumbed. Nearly all the large trees are found to have the core rotten near the ground, apparently without the health or vigor of the tree being at all impaired. Notwithstanding this early rotting of the core, the tree itself is so well known to resist decay, even when exposed to moisture or contact with the ground, that it is very generally used for the foundations of buildings, etc. Though it makes excellent sash and doors, it is not sawed into lumber here, and while superior to the firs, makes only indifferent fuel, as it burns too quickly.

Owing to its straight grain it rives easily, and on this account is much used for shingles, shakes, stakes, rails, etc., besides which it is a general favorite for fence posts, bridge piles, bridge flooring, and where accessible it is preferred for building purposes.

CHAMÆCYPARIS NOOTKATENSIS (Lamb) Spach. (Alaska cedar, yellow cedar.)

Of all the trees of this region the Alaska cedar is the most pronounced lover of moisture, and on this account it is not only confined to the moist valleys, but is further restricted to such only as head in or about the main divide of the Cascade Range. In not a single instance was it observed in the moist ravines or canyons elsewhere. Its altitudinal range was greater than anticipated, being from 2,100 feet on the Stehekin to 6,000 feet about the headwaters of the Methow and Rattlesnake Creek. The finest specimens of the tree are to be seen on the Stehekin and Agnes Creek, where it ranges from 50 to 75 feet in height and from 10 to 25 inches in diameter.

About its upper limits, particularly in Horseshoe Basin, the tree was quite alpine in habit and very much stunted in growth, but even the most stunted trees, some of which did not exceed 10 feet in height, were found to be fairly well covered with the typical small barbed cones, which take three years to mature their seed. This slow maturing of the seed, coupled with the moisture-loving habit of the tree, tends greatly to restrict its regional range. The branches are somewhat declined, and the branchlets mostly pendulous, giving the tree a dejected appearance in the forest.

The bark of the young tree is somewhat red and ~~stringy,~~ shreddy becoming checked and gray in age, when it bears a strong resemblance to that of *Thuja plicata*, but the mature tree, unlike the latter, continues perfectly sound at the core.

The wood is close grained, firm, and durable, and is undoubtedly the most valuable in this region. It takes a high polish, and is highly prized for cabinetwork and certain kinds of finishing.

JUNIPERUS ~~VIRGINIANA L.~~ scopulorum (~~Virginia~~ Mountain juniper, or red juniper; Piskwaus name, Pön-ilp.)

The regional range of this tree is more restricted than that of any other in the eastern portion of the reserve, being strictly limited to a few spots about the shores of Lake Chelan and its immediate vicinity, where the tree may be seen struggling for an existence in the dry, rocky soil. Its altitudinal range is equally as limited as its regional, extending upward only a short distance from lake level—1,108 feet. Not a single specimen was seen above 1,800 feet elevation.

The tree is much twisted and gnarled by the winds about the lake shore, but, notwithstanding this, appeared to be quite healthy, all the specimens observed being well loaded with the typical, glaucous-blue, berry-like cones, which take two years to mature their seed. It is quite stunted in growth in this region, the tallest tree seen not exceeding 30 feet in height, and the diameter ranging from 7 to 12 inches.

The sapwood is white, the heartwood a decided red, odorous, compact, and very durable. No economic use, however, is yet made of the tree.

JUNIPERUS NANA Willd. (Creeping juniper.)

This diminutive representative of the cone-bearing family—the only shrub among them—has an altitudinal range far exceeding that of any other tree in this region, being found from 1,100 feet on the shores of Lake Chelan to 7,500 feet, or timber line. Although usually favoring a moist habitat, it was found quite at home in very dry situations here, and in favorable locations was found well fruited with masses of dark-blue, berry-like cones. It is fairly common in sheltered, rocky spots about all the moist slopes and passes in this portion of the reserve. The only other shrub that at all approaches it in altitudinal range here is the Oregon box, *Pachystima myrsinites*, which ranges from 1,100 to 7,000 feet.

TAXUS BREVIFOLIA Nutt. (Pacific yew.)

The Pacific yew is the only diœcious conifer here, and has a very limited regional range, being found only on the Stehekin, in Horseshoe Basin, and about some of the passes. It ranges in altitude from 3,300 to 5,500 feet. All the specimens observed here were dwarfed and shrub-like, ranging from 8 to 18 feet in height, and none were seen exceeding 7 inches in diameter. The pistillate trees were sparingly fruited with a bright-red, fleshy, cup-shaped berry, quite sweet to the taste, and bearing one seed. The bark is thin, reddish, tough, and shraddy ~~stringy~~. The wood is close grained, tough, elastic, and very durable, but it is too rare here to be of economic value.

SALIX LASIANDRA LYALLI Sargent. (Lyall willow; Piskwaus name, Thl-köth.)

This hardy willow is the most common here, and has a considerable altitudinal range, being found from lake level, 1,100 feet, to 5,500 feet elevation. It appears to be little affected by altitude, the chief requisite being sufficient moisture. A specimen 65 years old at 5,100 feet elevation was found to be 39 feet in height and 7½ inches in diameter, while the largest seen at lake level was only 8 inches in diameter. The foliage is much eaten by stock wherever it can be reached.

SALIX FLUVIATILIS Nutt. (Longleaf willow.)

The longleaf willow has not nearly as great altitudinal range as the last, being mostly confined to moist situations about lake level. It ranges from 10 to 40 feet in height here, and the diameter rarely exceeds 6 inches. The foliage of this willow also is much relished by stock.

POPULUS TREMULOIDES Michx. (Aspen poplar.)

The altitudinal range of this tree is almost identical with that of the yellow pine, 1,100 to 6,000 feet. Though not common here, its regional range is considerable, and it may be found in small quantities even on the driest hillsides, but it is only along stream banks and in moist situations that it appears to find a favorite habitat or attain large size. One of the largest trees examined was found to be 75 feet high and 19 inches in diameter at stump height. It is occasionally used for fuel and for fencing, but it makes very indifferent material for either purpose.

POPULUS TRICHOCARPA Torr. and Gray. (Cottonwood, black cottonwood; Piskwans name, Thu-thilp.)

The cottonwood ranges in altitude here from 1,100 to 4,000 feet, and is mostly confined to the moist valleys and canyons, where it sometimes attains magnificent proportions, ranging from 12 to 48 inches in diameter and from 60 to 100 feet in height.

In the rich river bottoms the young trees grow in dense thickets and the foliage attains a very large size, as compared with that of the grown tree. The bark of the young tree is smooth and green, strongly resembling that of the poplar, but the bark of the grown tree is gray and roughly seamed and more nearly resembles that of the basswood or the Oregon maple. The wood makes very fair fuel and is used to some extent for that purpose, and is also split into rails. Its principal economic use here at present, however, is the manufacture of berry, grape, peach, and fruit boxes generally.

ALNUS OREGONA Nutt. (Red alder; Piskwans name, Kuh-skwē′alp.)

This is the commonest alder here, and ranges in altitude from 1,100 to 5,500 feet. When found in dry situations it only grows to shrub-like proportions, but in the moist valleys and along stream banks, particularly at the lower elevations, it attains a sufficient size to be classed as a tree.

Along the banks of some of the smaller perennial runs it forms in places a fringe so dense as to necessitate seeking an opening to cross them.

SORBUS SAMBUCIFOLIA (C. and S.) Rœm. (Mountain ash, elder-leaf mountain ash.)

This mountain ash, which in many places attains the dignity of a tree, is here only a shrub. It is confined to moist mountain slopes and to the higher portions of the moist valleys, where it ranges in altitude from 2,700 to 5,000 feet. It is well fruited with great clusters of exceedingly acid, inedible berries, whose brilliant red color makes it a noticeable object on the mountain sides in late autumn.

SORBUS OCCIDENTALE (Wats.) Greene. (Little mountain ash.)

This was found to be much rarer, more shrub-like and more alpine than the last named. It was observed only in Horseshoe Basin and on Agnes Creek, where it ranges in altitude from 3,100 to 6,000 feet. The fruit is smaller and less abundant than that of the preceding, but is equally acid and inedible.

AMELANCHIER FLORIDA Lindl. (Service berry, western service tree.)

One of the commonest shrubs here is the service berry, apparently as much at home on the dry hillsides as in the moist valleys, and ranging in altitude from 1,100 to 5,700 feet; it is only at the lower elevations that it grows to be tree like in size. It is missing from the lodgepole-pine belt, but reappears again above, and is observed in a considerably dwarfed form a little below snow line in Horseshoe Basin. About the lower levels it bears great quantities of sweetish edible berries, the amount of fruit borne gradually diminishing toward its upper limits, but even near snow line in Horseshoe Basin it is still found to bear fruit.

CRATÆGUS DOUGLASII Lindl. (Western haw.)

This tree is not common in any part of this region, being mostly confined to the lake level and to moist slopes and stream banks. It bears a fair amount of dark edible fruit that is almost black when ripe. Forked sections of the smaller parts of the trunk are much used here by settlers, packers, and Indians for making the hooks used on the end of the cinch in packing, as it is the toughest and best wood to be found for this purpose.

CRATÆGUS SP. (No. 803.)

This shrubby haw was observed only about the lower limits of the white-bark pine. The specimen collected was found at 6,100 feet elevation.

PRUNUS EMARGINATA (Doug.) Walp. (Bitter cherry.)

This tree ranges in altitude from 1,100 to 3,500 feet, but toward its upper limits it is more or less shrubby in form and size. Wherever seen it was loaded with large quantities of luscious-looking but exceedingly bitter fruit which neither man nor beast will eat. The amount of fruit borne is apparently not much affected by altitude, as even about its upper limits it is well fruited. A peculiar fact regarding this tree is that when the cultivated cherry is grafted on to the stump of this one by fruit growers, the tree is not only healthier and hardier but the fruit is found to excel in flavor that of the cultivated cherry when grown on its own stump.

PRUNUS DEMISSA (Nutt.) Walp. (Western chokecherry; Piskwaus name, Puh-kal-uh-halp; fruit, Puh-kal-uh.)

The chokecherry is quite common here and has an altitudinal range identical with that of the preceding. The amount of fruit borne is even greater than on the bitter cherry, and has the further advantage of being edible. Both tree and fruit were observed to thrive best on the benches near lake level.

ACER MACROPHYLLUM Pursh. (Oregon maple; Piskwaus name, Thlŭh-thluh-al-pitch-kil.)

The Oregon maple was found to be fairly well distributed over this whole region, although it generally prefers the moist slopes and stream banks. It attains its greatest development, however, in the rich river bottoms like the Stehekin, where it ranges from 10 to 25 inches in diameter and from 40 to 70 feet in height. Outside of such valleys it rarely exceeds 8 inches in diameter. It ranges in altitude from 1,100 to 3,500 feet, but decreases rapidly in size toward its upper limits. The wood is straight grained, compact, quite suitable for lumber, and excellent for fuel, but the latter is the only economic use yet made of it here.

ACER CIRCINATUM Pursh. (Vine maple.)

This straggling tree was observed only in the Stehekin Valley, where it ranges in altitude from 1,150 to 4,000 feet. It requires much more moisture than the preceding, but is not of any economic value.

ACER GLABRUM Torr. (Dwarf maple; Piskwaus name, Sum-whum-alp.)

The dwarf maple is capable of withstanding a much drier climate than either of the two preceding, and consequently its regional distribution here is much greater. Its altitudinal range is also greater, being from 1,100 to 4,500 feet. It is a very small tree even in favorable situations, and is generally only a shrub. It has no economic value. Fully 50 per cent of the specimens observed had the foliage much affected by a bright-red fungus.

CORNUS NUTTALLII Aud. (Western dogwood; Piskwaus name, Pil-pil-alp.)

This tree is very showy in the woods in spring, owing to the great white involucres surrounding its flowers. It is still more noticeable here in late autumn, when the masses of bright-red berries, the rich dark red of the foliage, and the glaring white involucres of its autumn flowers combine to make it a very conspicuous tree in the forest. Its altitudinal range is quite limited—1,100 to 2,500 feet—and it is mostly confined to moist ravines and stream banks. In moist valleys like the Stehekin it grows large enough to be used for fuel.

CORNUS BAILEYI Coult and Evans. (Bailey's dogwood; Piskwaus name, Shtuksh-walp: fruit, Shtä-kluh.)

Though classed as a shrub, this is entitled to notice on account of its habit of growing in dense thickets on the moist river bottoms, where it is sometimes almost inpenetrable. It was not observed outside of the moist ravines and valleys, and ranges in altitude here from 1,100 to 3,000 feet. Wherever seen it was well fruited with great masses of white to bluish-white berries, which form the favorite food of pheasants in autumn.

SAMBUCUS CALLICARPA Greene. (Redberry elder.)

This occurs only as a shrub in the moist valleys and canyons of this region, where it has a rather peculiar altitudinal range—2,790 to 6,000 feet. It was observed almost up to snow line in Horseshoe Basin, and bore fruit only sparingly wherever seen.

SAMBUCUS GLAUCA Nutt. (Pale elder; Piskwaus name, Chu-kweek-winlp; fruit, Chu-kweek.)

The pale elder is much more common than the preceding, and, though generally preferring the ravines and valleys, may also be found on the moist slopes and hillsides. It ranges in altitude from 1,100 to 4,000 feet, but attains tree-like proportions only about its lower limits. At all altitudes it was found to bear fruit in such immense quantities that the branches were bent downward by the weight of the great masses of its pale glaucous-blue berries.

FOREST FIRES.

There can be no doubt in the mind of any thoughtful observer who has traversed this region that it was once much better forested than it is at the present time. The cause of this deforestation is not far to seek. The numerous burnt stumps, the bare slopes of the west and southwest faces of the hillsides, the charred and dead trees, the burnt areas of different ages, and the paucity of humus outside of the moist ravines and valleys all attest that the region has been burned over, not once, but many times. Of the whole region traversed by our party during the season, a few small spots about the passes and a small tract on Bridge Creek were the only sections that showed no evidence of ever having been visited by fire. Even the moist valleys of Stehekin River, Early Winters Creek, and Railroad Creek gave ample proof of having been burned over seriously more than once.

According to the testimony of settlers, some forest fires occur here every summer; for instance, during the present season, in addition to three simultaneous fires in the vicinity of Lake Chelan, there were also one on the Entiatqua divide and two in the Methow Valley. They further allege, apparently on good evidence, that this region had been burned over long before the coming of the first white settlers. This is well borne out by the scarred bases of the mature trees in the yellow-pine belt, nearly all of which show traces of more than one forest fire. As the two principal trees of this belt—the yellow pine and red fir—are well fruited with fully seeded cones, the great paucity of seedlings and saplings in this belt is undoubtedly attributable in a much greater degree to fires than to dryness of climate, as the repeated burnings have so deprived the soil of humus that the seedlings fail to take permanent root, and sooner or later perish.

In the yellow-pine belt the first visit of a forest fire rarely does more than burn the dry grass, kill the saplings, and scorch the bases of the grown trees, but a second or third fire usually results in the destruction of many fine timber trees. A slope or hillside in this belt with south or southwest exposure that has once been completely burned over seldom or never becomes reforested; but the north or northwest exposures, where burned, are generally found to be slowly recovering.

In the lodgepole-pine belt, on the other hand, a forest fire at any time proves most disastrous, as even on the first visit, if there is a high wind, many trees are burned outright, or, if not, the fire slowly burns in the humus about their roots until the trees are uprooted or destroyed, while a second or third fire over such a tract rarely leaves a living tree of this species. Besides its dense growth, the liability of this tree to injury by fire, and the number of windfalls and broken trees, tend still further to make a fire in this belt exceedingly destructive. The wind also does much more damage in this belt than in any other by uprooting and breaking so many of the trees that on the approach of a serious forest fire this material acts as fuel among the green timber and seriously aids in the destruction of the surrounding forest.

On August 13, about the head of Twenty-five Mile Creek, we examined a large tract in this belt that had recently been burned over by a fire left by a careless sheep herder who had been grazing his flock in the vicinity. This was apparently the first fire that had occurred here, but the destruction was most complete and not a single sapling escaped. The trees, of which about 75 per cent were lodgepole pine and 25 per cent subalpine fir, were burned, fallen, and uprooted on all sides, less than 3 per cent of the trees, large or small, having escaped. Even the humus was so totally burned that nothing but a dry, powdery ash mixed with charcoal dust was left, into which one sank ankle-deep at every step, and each footfall sent up such a cloud of dust and ashes that after walking a mile or two one looked like a coal heaver or chimney sweep. A few smoldering logs still lay about, in proof of the recent time of the fire, while the quantity of dead and fallen trees left will prove a source of danger to any new growth that might appear for many years. The lodgepole pine being so slow in growth, and all of the full-grown trees of that species being more than one hundred years old, it will probably take a century, in the slow process of nature, to reforest this tract to the extent existing before the fire, while the loss to the soil by denudation in its present unprotected condition is irreparable.

The subalpine-fir belt suffers next to that of the lodgepole pine in the amount of injury done by forest fires. The most typical example in this belt seen during the trip was on Rattlesnake Creek, where the parties who were making the trail to the Slate Creek mining district in 1895 set fire to or allowed the fire to run in a large tract of forest here, composed of *Abies lasiocarpa*, *A. amabilis*, and *Picea engelmanni*. In this tract about 75 per cent of the trees had been destroyed, very few of them having been burned outright, but the heat from the burning resin vesicles in the bark of the firs was sufficiently intense to cause the bark to blister or separate from the trunk, thus destroying the trees. These two firs being much more deeply rooted than the lodgepole pine, very few of them had become uprooted or had fallen, nor was the humus destroyed to anything like the extent it had been in the tract of lodgepole pine referred to above. Though the bark of the Engelmann spruce does not blister from excessive heat, like that of the firs, the fire was proportionately more fatal to it than to the latter, and wherever burned about the base the trees perished. This belt appears to recover from the effects of a fire more readily than any of the others, and more saplings in proportion to the number of grown trees were seen here than anywhere else outside of the moist valleys.

In the white-bark-pine belt the loss of timber by a forest fire is comparatively light, but the damage to the soil is very great. Once the grass is burned off these elevated slopes and ridges, the amount of denudation caused by water from the accumulated snows of winter is so great that it requires many years for vegetation or young seedlings to regain a foothold there.

The damage resulting from a forest fire in the moist ravines and valleys is much greater than, in their moist condition, one would suppose possible. The tree growth is much denser, the saplings and young deciduous trees are more numerous, and the quantity of humus and forest litter is very much greater than in the region outside of these valleys. This abundance of humus and forest litter is undoubtedly the cause of fires continuing so long and creating such havoc in the inclosed valleys. Even when the bottom lands of a valley are too moist to be much injured by fire the slopes on each side will continue smoldering and burning until quenched by the fall rains.

Judging from the universal traces of fire in the forest, the number of old burnt tracts where reforestation has failed to take place, and the abundant evidence of the damage done during this season alone, it is safe to estimate that 50 per cent of the trees of the eastern portion of the reserve have been destroyed by fire, while the total amount used for lumber, fuel, and other economic purposes will not exceed 5 per cent.

Among the principal causes of forest fires may be named sheep herders, campers, hunters, prospectors, miners, trail and road makers, and settlers. The first named are generally the most culpable. Some of the numerous camp fires which they make as their herd moves from place to place are allowed to ignite the surrounding forest, by accident or by design, and fires once started in this dry region are seldom extinguished before the arrival of the fall rains or until they burn out for lack of more material to feed on.

Campers and hunters are mostly to blame for carelessly neglecting to extinguish their fires thoroughly on moving or breaking camps. A camp fire supposed to be burned out is frequently found to be still smoldering in the humus, and only awaits a favorable wind to flare into activity and spread to the nearest timber.

Prospectors and miners frequently set out a fire for the purpose of clearing off the ground, so that the rock or ledge may be more accessible and the claim or mine more easily worked, and the fact that the fire may communicate to the adjoining forest and destroy much valuable timber is entirely ignored or lost sight of.

There are few roads in this region, but the State and private parties have made numerous trails to the mines and over the passes, and in almost every instance a line of charred and burnt forest was found to exist in the vicinity of these trails. This is sometimes caused by the carelessness of the contractors or laborers in allowing their work fires to spread, but occasionally it is the result of design on their part, for the purpose of clearing off the timber and facilitating the making of the trail. One of the most seriously burnt tracts of timber seen in the reserve was along the line of the trail from the Methow Valley to the Slate Creek mining district.

The settlers in and about this portion of the reserve are responsible for many of the forest fires, perhaps not intentionally. It is, however, a well-known fact that a fire once started for the purpose of clearing land is seldom or never confined to the tract to be cleared, but gradually finds its way into the adjoining forest, where it continues until burned out or extinguished by the fall rains. One of the fires seen in the Methow Valley had its origin in this way. Nearly all the ranches here are in the yellow-pine belt, and the customary method of clearing the land of large timber is to "ring" the trees for a year or two until dead and fairly dry. The fire is then set out, and spreads rapidly along the dry grass till it reaches the trees, when it ignites the pitch oozing from the "ring" or cut and, spreading, soon envelops the tree. The only precaution taken by the rancher is to set out the fire to the leeward of his buildings or fences, and then no effort whatever is made to prevent it from reaching the neighboring timber. Even his own fences frequently fall a prey to the devouring element, which a high wind soon places beyond his control.

The fire-resisting power of the trees in this region varies greatly in the different species. The thick bark of the yellow pine and red fir enables them to survive a fire to which most of the others would succumb, and it is some matter of doubt which of them possesses the greatest fire-resisting qualities. The Pacific arbor vitæ and Alaska cedar, although thin barked, are deep rooted and nonresinous and resist the attacks of fire fairly well. The highly resinous bark of the subalpine and amabilis firs leaves them an easy prey to forest fires, while the Engelmann spruce, though not resinous barked, is fully as vulnerable as either of the firs, probably owing to its thin, scaly bark and the paucity of sap in the tree itself.

A list of the principal conifers here, in the order of their resistence to fire, would be about as follows:

1. Pseudotsuga ~~taxifolia~~ mucronata, (Raf.) Sudw .... Red fir.
2. Pinus ponderosa, Dougl .... Yellow pine.
3. P. albicaulis, Engelm .... White-bark pine.
4. Tsuga pattonii, (Jeff.) Coville .... Patton's hemlock.
5. Thuja plicata, Don .... Pacific arbor vitæ.
6. Chamæcyparis nootkatensis, (Lamb) Spach .... Alaska cedar.
7. Larix occidentalis, Nutt .... Western larch.
8. Juniperus ~~virginiana, L.~~ scopulorum, ... ~~Red~~ Mountain juniper.
9. Tsuga pattonii hookeri, Lemmon .... Hooker hemlock.
10. Pinus murrayana, Balf .... Lodgepole pine.
11. P. monticola, Dougl .... Mountain white pine.
12. Tsuga mertensiana, (Bong.) Carr .... Western hemlock.
13. Abies amabilis, (Loud.) Forbes .... Amabilis fir.
14. A. lasiocarpa, (Hook.) Nutt .... Subalpine fir.
15. Picea engelmanni, Engelm .... Engelmann spruce.

FOREST PRESERVATION.

The rapidity with which our forests are being denuded for lumber and fuel, the immense amount of timber destroyed each year by forest fires, the value of our timber as a natural resource, and the importance of the forest in the conservation of the water supply, particularly in a dry climate like that of this region, all tend to make forest preservation a question on which the average citizen should be much better informed than he is at present.

The history of all countries where forests have been neglected or destroyed is similar. The more mountainous the region and the drier the climate the more serious the resulting damage. First, great freshets in the streams in spring, with consequent soil erosion; next, drying up of the stream beds and desiccation of the soil in summer, followed by climatic changes and the failure of crops without irrigation. Even now the successful raising of crops in this region can be assured only by the use of irrigation, and already many of the small runs which formerly contained water throughout the season are dry in summer, owing to the removal of the forest covering about their sources and, consequently, too early melting of the snows in spring. Outside of the moist valleys the lodgepole-pine belt contains the densest growth and, consequently, by preventing too rapid evaporation from the soil and retarding the melting of the snow, is the greatest conservator of the water supply. It is also the zone most liable to damage by fire, and on this account is entitled to great consideration in the matter of forest protection. The snow in the yellow-pine belt disappears very early in spring, and for the remainder of the season this belt must depend for its moisture, to a great extent, on the belt of the lodgepole pine above.

The apparent indifference of the public to the importance of this matter is undoubtedly due in great measure to misconception and lack of information on the subject, and it is but fair to our more intelligent citizens to assume that when they are made fully aware of the dangers of delay or neglect, forest preservation will receive the consideration to which it is entitled.

The erroneous ideas that have prevailed in the popular mind for many years regarding the inexhaustibility of our timber supply on the Pacific coast are largely responsible for the great recklessness with which our forests are laid waste and the utter apathy and lack of interest of the general public in all matters relating to forest protection or preservation. The ignorance, sensationalism, and sectional boastfulness of newspapers are chiefly responsible for the spread of such pernicious ideas, and the error of such statements can not be pointed out too forcibly, nor the public mind be educated too promptly to the fact that our forests are fast disappearing and unless protected will in the course of another generation become so limited as to be barely sufficient for local consumption. Not only the newspapers but the sheepmen as well are instrumental in circulating these mischievous ideas regarding the unlimited supply of timber in our forests. The former have at least the excuse for their misstatements that they are made for the public-spirited purpose of booming their own particular section, but the latter have no excuse whatever, and are actuated only by cupidity. In order to obtain free grazing in the forest reserves for their omnivorous herds, they seek to lull the public into complacent indifference under the pretext that the forests are inexhaustible and that the grazing of sheep in them entails no injury or reduction of the timber supply. It is only necessary for a careful observer to examine a forest in which a band of these "hoofed locusts" have grazed and their careless herder with his numerous camp fires has dwelt for a season to have so fallacious a theory completely dispelled, and to become thoroughly convinced that the need of forest protection and supervision is imperative.

One frequently hears the statement made, by persons presumably capable of knowing, that "there is just as much timber in this State now as there was when the first white settlers came"; the theory being that the growth of red fir is so rapid as to counterbalance the amount of timber used and destroyed each year. A more erroneous idea than this would be hard to conceive, and it should unhesitatingly be corrected. It is quite true that the growth of this tree is very rapid in the open woods on the west side of the Cascade Range, where trees can be found large enough for railroad ties at 40 years old, but on the east side of the range, or in a dense forest, the growth is very much slower, and a tree large enough for this purpose would be 80 years old. Trees of this species large enough for lumber purposes have to be 200 years old or more, and thousands of square miles of forest on this coast have been overrun by fire since the arrival of the first white settlers, to say nothing of the lumber and fuel consumed.

That our forests are diminishing at an alarming rate, there can be no doubt, and it remains for the Federal Government to devise some system by which the reserves may be controlled and supervised so effectually that damage from forest fires will be reduced to a minimum, and that persons responsible for fires will be held strictly accountable.

The first step in this direction should be the strict maintenance of our forest reserves as at present constituted.

DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

THE

PIKES PEAK, PLUM CREEK, AND SOUTH PLATTE FOREST RESERVES

Colorado

BY

JOHN G. JACK

EXTRACT FROM THE TWENTIETH ANNUAL REPORT OF THE SURVEY, 1898-99
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SITUATION.

These three reserves, known as the Pikes Peak Timber Land Reserve, the Plum Creek Timber Land Reserve, and the South Platte Timber Land Reserve, are all contiguous at some part of their boundaries, and are situated between latitude 38° 45′ and 39° 45′, and between longitude 104° 45′ and 106° 15′ west from Greenwich (Pl. VIII, in pocket). The situation is practically in the very center of the State, Colorado Springs lying just outside the eastern boundary line, while the western limit is several miles east of Leadville. The three reserves are practically contained within the counties of El Paso, Douglas, Jefferson, and Park, nearly half the total area being in the last-named county. Very small areas on the south and west are understood to be within the jurisdiction of Chaffee County and Summit County.

The Pikes Peak Timber Land Reserve contains about 184,320 acres; the area of the Plum Creek Timber Land Reserve is placed at 179,200 acres; while there are 683,520 acres in the South Platte Timber Land Reserve, about one-fourth of which lies in Jefferson County and the remainder in Park County. The total area of the three reserves, therefore, amounts to about 1,047,040 acres.

In general outline the Pikes Peak Reserve is a parallelogram 30 miles in length by 9 miles in width, with some small unreserved areas within these parallel lines and some reserved tracts extending beyond them.

The Plum Creek Reserve is somewhat triangular in outline, the south, east, and north sides being arbitrary straight lines, the west side being the South Platte River.

The South Platte Reserve is extremely irregular in outline, the main body of it lying south of and having for its northern boundary the North Branch of the South Platte River, while South Platte

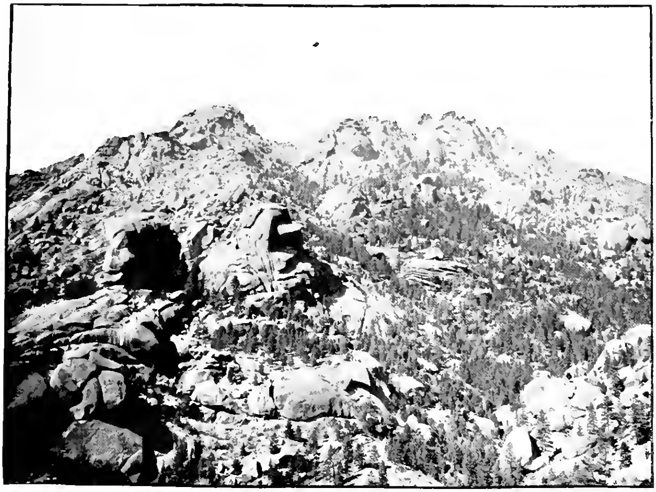
River itself separates the reserve from the Plum Creek Reserve on the east, and a large unreserved tract 16 miles in width lies between its southern portion and the Pikes Peak Reserve. Between the main body of the South Platte Reserve and its extreme western portion lies South Park, an extensive, comparatively level, and open grazing region, 24 miles in width in its widest part and over 50 miles long, which is not included in the reserve. The extreme western portion of the reserve, lying between this unreserved portion and the longitude of Leadville, is the narrowest and most irregular of all, varying in width from 11 miles at its southern end to 1½ miles near Alma.

With the exception of the natural boundaries formed by the rivers mentioned, the limits of the reserves are purely arbitrary, following the straight section or township lines drawn by surveyors. On this account, and as there are no fences or well-defined points to mark the actual boundaries, they are but little known or respected, and the result is that there is locally frequent disagreement as to how far the reserve lines extend, and it is not unusual to find settlers who are not aware that they are located within the area set apart by the Government for the preservation of the timber and the conservation of the water supply.

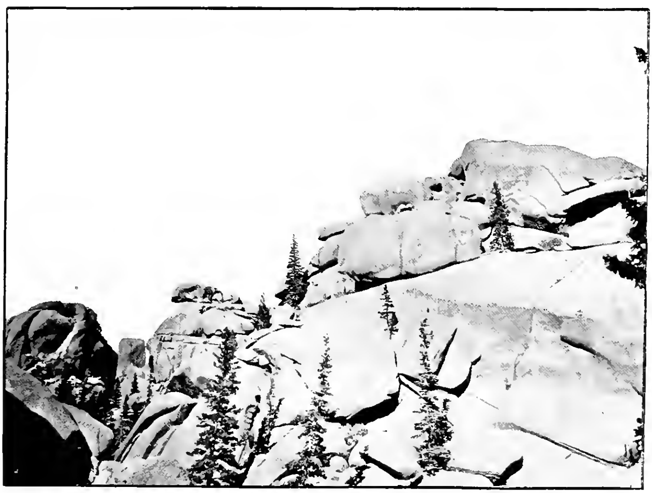
GENERAL SOIL CONDITIONS.

Throughout almost all parts of the three reserves disintegrated granite soils, often resembling finely broken gravel, are everywhere manifest, and the abundant granite rocks and mountains from which the soils have been derived show the general geological character of the country; and it is only on a very limited strip along the lowest eastern edge of the Pikes Peak and the Plum Creek reserves that the tilted sandstone formation, so conspicuous and well known at Manitou, is evident. There are frequent outcroppings of quartz and other rock in different parts of the reserves, and prospecting has shown that mineral-bearing material is likely to be found almost anywhere. On the western arm of the South Platte Reserve limestone and volcanic rock are abundant.

On the higher mountains the broken granite is generally piled in great masses, as on Pikes Peak, or in huge weather-worn blocks, as on some of the Tarryall peaks to the west. In the course of ages the interstices between these rocks have become filled with smaller fragments upon which minute plants grow, thus forming some humus upon which other species grow more vigorously, so that some vegetation, like lichens, grasses, sedges, and other herbaceous plants, is found at the top of the loftiest summits. In natural hollows or cavities and with decreasing altitude and deeper deposit of decayed granite and



A. VERY ROCKY SLOPES EAST OF TARRYALL MOUNTAINS, LOOKING ACROSS LOST PARK CREEK.



B. ENGELMANN SPRUCE AND DOUGLAS SPRUCE ON GRANITE ROCKS ALONG LOST PARK CREEK.

humus the vegetation is richer and more rank, including various species of dwarf shrubs.

On steep slopes the finer material and humus is necessarily accumulated in pockets, and in the ravines and gulches through which streams run, the greatest accumulation of humus is found.

Wherever the soil has been increased by winds blowing débris or sand from other places, or where it is subject to accretion by washing, the decayed granite and humus is commonly found more or less mixed. The decaying roots of trees and other plants in the soil also add in a small degree to the fertility. Throughout the greater part of the reserves, however, there is a general and very noticeable absence of humus or accumulation of decayed vegetable matter of any kind, which is no doubt largely due to the dry conditions favorable for oxidation and to the prevalence of both heavy forest and light ground fires at various times, as well as to the general poverty of the natural living vegetation itself. Probably not 5 per cent of the entire area bears any appreciable amount of humus over the coarse material beneath, and most of such humus as exists is shallow, not more than from 1 to 6 inches in depth.

As a rule the lower hills are rounded and formed of great beds of disintegrated granite resembling small gravel or coarse sand, upon which most of the forest and vegetation grows. Naturally the material accumulated near the base of the hills and in the gulches is of finer composition and contains more vegetable matter than that found above, and this is shown in the finer development of the trees and plants, although increased moisture and shelter are also factors to be considered in connection with improved soil conditions.

The granite rock shows much variation in character in different parts of the reserves. For the most part natural decay and disintegration are very evident; but in some areas the rocks present a hard, polished, and enduring surface, and the wearing away of these areas proceeds more slowly, and great bare masses often rise conspicuously above the surrounding territory. In cracks and crevices of these rocks and bowlders the seeds of trees and shrubs have sometimes lodged, and, germinating, have survived droughts and storms, although often dwarfed and growing very slowly under these trying conditions. These plants serve to hasten the disintegration of such rocks.

Along some of the narrow valleys through which streams run, time has brought in an accumulation of plant-food material, which is the basis of the small farms or ranches which have been established in the most available and suitable sites in the reserves. Although the coarse sandy or gravelly soil on many areas looks unproductive, fair crops of grass and a few other farm products are raised wherever artificial irrigation can be applied. Manures or artificial fertilizers are seldom used except by a very few of the more progressive and industrious farmers.

Rarely, the humus or "muck" is of considerable depth in natural basins, as near Lake Moraine. There are many acres of boggy ground in the high Lost Park region, and much humus occurs south and southwest of Florissant.

CLIMATE AND RAINFALL.

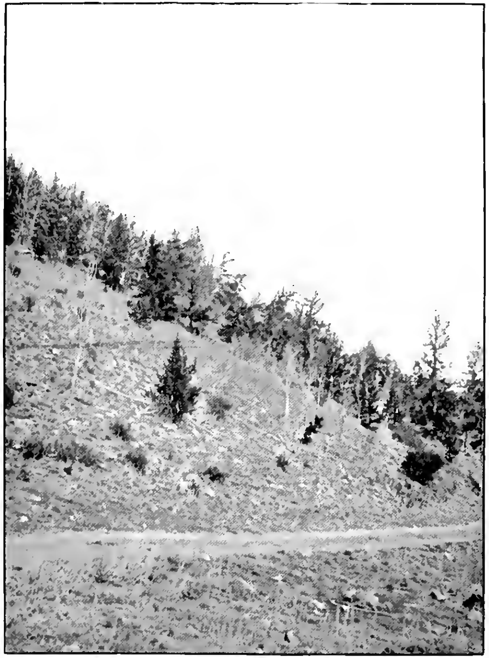
The great elevation of this whole region gives it a comparatively cool summer, with liability of nightly frosts near the timber line. On the so-called agricultural areas, mostly devoted to grazing, snow sometimes falls in midsummer and frosts are not very rare. On this account the variety of crops it is possible to raise within the reserves is very limited, consisting chiefly of hay, oats, barley, rye, and a little wheat in some localities at the lower altitudes. Alfalfa is also grown locally on the lowest levels, where potatoes also can be grown successfully, although it is not economically profitable to attempt the cultivation of this crop at altitudes above 8,500 feet. The growing season is short, as is plainly shown in the slow growth of the trees. In winter the temperature at 8,500 to 9,000 feet altitude sometimes falls to 20° or 30° below zero.

As showing the possibilities in this country, it may be mentioned that on July 19, 1897, there was hard frost, with several inches of snow, throughout the country from Manitou Park (8,000 feet altitude) to South Park, and snow and frost was recorded at Florissant (8,500 feet altitude) on July 1, 1898.

There exist few accurate records of rainfall taken at various points and during a number of years to show the average annual precipitation of this region. The Weather Bureau maintained a station on the summit of Pikes Peak, at over 14,000 feet altitude, during fifteen years, and the average during that time was 28.65 inches, the extremes being 9 and 40 inches. At Colorado Springs, at about 6,000 feet altitude, or 8,000 feet lower than the summit of Pikes Peak, the average during the same years was a little less than 15 inches. As a rule the precipitation decreases rapidly with decrease in altitude. Additional observations were taken during several years in or near South Park. The average annual rainfall of the whole region covered by the reserves may be placed at between 16 and 18 inches.

This small rainfall, combined with the dry atmosphere, poor soil, and cool climate, causes nearly all the natural vegetation to be of relatively slow development, and nowhere can there be said to be a strong, rank growth, such as would be found in more fertile, warmer, and more freely-watered regions of nearly the same latitude.

The snowfall is heavy on some of the mountains. Snowslides, however, are very rare, although they occur more frequently on the mountain slopes located outside the western limits of the South Platte Reserve.



A. CHARACTERISTIC SOUTH SLOPE ALONG WESTON PASS ROAD.

Growth of scrubby pine.

B. CHARACTERISTIC NORTH SLOPE ALONG WESTON PASS ROAD.

Good growth of Engelmann spruce and some lodgepole pine.

There are no data to show that there is any less average annual rainfall than existed fifty years ago.

It is the general testimony of persons who have lived longest in the central part of Colorado that there is now a decided diminution of water in the streams compared with the flow of water twenty-five or thirty years ago. This refers especially to the summer flow, as there is more than the normal amount of water in the early spring. The causes are, locally, variously attributed to excessive pasturage, by which the ground becomes trampled hard and the protecting vegetation along streams destroyed; to the cutting of timber along streams, particularly at high altitudes; and especially to the great areas which have been denuded of forest by fires, allowing the snows to melt more rapidly and the waters to flow off less gradually than they did under conditions existing before the earliest settlement of the country.

FOREST CONDITIONS.

Of all the reserves established by the Federal Government, the three under consideration have probably been the most damaged by fire and been subject to greatest depredations by timber cutters. A comparatively small portion of the total area fails to show traces of forest or surface fires, some of the more recently burned sections presenting a desolate aspect, which under present natural developments is likely to continue for many scores of years. There are a very few thousand acres of merchantable timber where the ax has not been used with evident effect. The best of the remaining timber can not be called large, but it is greedily sought by the lumbermen, who take any kind of sufficient dimensions without much discrimination regarding species. Such forests as exist are generally open and may be traversed by wagon or on horseback, and it is only on comparatively limited areas that any close or dense growth of trees is encountered. In young growths of lodgepole pine only are there what might be called thickets, and occasionally a dense growth of small red fir and its accompanying species is found on some locally favored northern slope.

In a few places at high altitudes there is much dead and fallen timber among the living, piled 2 or 3 feet deep, this deadwood usually representing the accumulation of many scores of years; but this condition is rare in the reserves, although common in forests in other parts of the west.

On the high altitudes, or between 10,000 and 11,500 feet, the forest growth is generally most dense, but much depends upon exposures or slopes. The forest found on slopes facing the south is usually greatly inferior to that growing on the colder, shaded northern slopes, pines usually prevailing on the former and spruce on the latter; but on steep southern slopes the pines are commonly thinly distributed, small in size, and often so much branched as to be nearly worthless for commercial purposes (Pl. IX). Indeed, the southern slopes are sometimes practically bare of timber of any kind, when the opposite northern slopes are well covered.

The generally open character of the forest over a large part of the reserves allows of the growth of grasses and herbaceous plants, which usually occur in tufts or bunches and furnish a limited amount of food for cattle, the grasses naturally being most abundant on the cooler slopes, in gulches, and in the vicinity of streams.

On timber areas burned over at high altitudes the grasses generally spring up in greater abundance, excepting on some of the more arid or dry, warm southern slopes.

The tops and branches of trees cut by lumbermen are rarely accumulated in great masses in the open forest, the tops of each tree cut usually being isolated, because suitable sawmill timber is so scattered. They do, however, furnish material to increase the destructiveness of fires. The finer and softer parts of this refuse material soon decays and about it a few unusually vigorous grasses are generally found.

FIRES.

Probably at least 75 per cent of the total area of the reserves clearly shows damage by fire, much of it within the last half century or since the advent of white settlers in the region; and a great deal of ground shows traces of fires, which must have occurred prior to that time, and the forest has partially recovered the areas then burned over (Pl. X, in pocket).

LUMBERING.

Lumbering is carried on at all seasons of the year, although it is generally stated that cutting in autumn and winter is preferable. The trees furnishing the lumber are almost exclusively yellow pine, red fir, and Engelmann spruce, while some lodgepole pine and blue spruce are also used when found large enough in the localities in which they grow.

The trees are usually felled by sawing nearly through and wedging the side on which the cut is made, so that the tree falls in the opposite direction. Trees and logs above a foot in diameter are usually taken, although some of the smaller sawmills accept logs not less than 8 inches in diameter at the small end. The logs are cut in various lengths, usually 12, 14, or 16 feet, the branches and tops being trimmed off and generally allowed to remain and decay on the ground.

The logs are usually drawn to the loading skids by single horses trained to the work, and are hauled to the mill in wagons. The active mills are exclusively portable steam sawmills, with a capacity varying from about 5,000 to 25,000 feet of lumber a day. The fires for the

A. MISTLETOE INJURING YELLOW PINE IN SOUTH PLATTE RESERVE

B. YELLOW PINE SAID TO HAVE BEEN KILLED BY DRY WEATHER, SOUTH PLATTE RESERVE

boilers are fed by refuse lumber left in cutting. The saws used are thick, and about 25 per cent of the sawn timber is lost in sawdust when the lumber is sawn into boards an inch thick, the saw taking a quarter of an inch with each cut.

All of the hauling of logs to the mill and of the lumber to market or shipping station is done with lumber wagons and 2- or 4-horse teams. It is now commonly necessary to haul the lumber considerable distances, requiring a day or longer to make a round trip to and from a shipping station.

No timber or lumber is now floated down any of the streams, although formerly a small amount appears to have been carried in this way. Lumber roads or trails have been made to the best timbered areas in all parts of the reserves, so that there is no great difficulty in getting to almost any part. The length of the haul to market has been the chief factor in preserving such good timber as still remains uncut.

DISEASES AND ACCIDENTS TO TIMBER TREES.

As a general rule the forest trees appear to be in a healthy condition and seem to be subject to few diseases caused by insects or fungi, the cool climate and dry atmosphere, no doubt, being adverse to these pests, which are often so destructive in other parts of the country more favorable to their development. Even dead timber, often standing dry for twenty or thirty years, is little damaged, although borers generally attack the base of such trees. Occasionally tips of twigs of red fir or yellow pine were found affected by destroying insects, and the cones were sometimes destroyed by insects burrowing into them. Larvæ of a species of *Clisiocampa* sometimes defoliate the quaking aspen over a wide range of territory, and when this defoliation is repeated during several successive seasons the trees usually die, to be succeeded by new stems from the roots. While the aspen is of comparatively little commercial importance in this region, it is, when large enough, used for the manufacture of excelsior, or for paper pulp, and the defoliation of the plants prevents them from attaining merchantable size.

The most serious damage to the development of the yellow pine, lodgepole pine, and Douglas spruce noted was caused by three small species of mistletoe belonging to the genus *Arceuthobium* (*Razoumofskya*, Hoffm). This parasite was found to check and distort the growth of a great many trees in some localities, and in some cases it eventually caused their death. Affected trees are often dwarfed and have their branches shortened or distorted by it, and those bearing the parasite are usually readily detected. Trees of various ages and sizes are afflicted, from those only a few years old and a foot or two high up to those 150 years or more of age and 40 or 50 feet or more in height. As the parasite occasionally occurs on at least 50 per cent of the young trees, it may be readily seen that the normal development of timber is seriously interfered with. Fortunately these parasites are not very generally distributed throughout all places where their hosts grow.

In some parts of this mountainous country a great many trees are annually struck by lightning, which sometimes causes death, sometimes kills only the top or some of the limbs, or leaves signs of its work by a split in the trunk, injuring its value for lumber.

Ground or surface fires or timber fires have often left the trunks scarred or have destroyed the bark on one side, causing a defect which injures the tree for lumber.

Snowslides of sufficient magnitude to damage timber are rare, although they sometimes occur on the high mountains west of the South Platte Reserve. At low altitudes heavy snowstorms occasionally break down large numbers of young trees, or the tops of older ones, both conifers and aspen. Besides the damage to timber, the dry débris thus formed increases danger from fire.

Occasionally local windstorms or hurricanes occur with sufficient force to blow down large areas of green timber, either by uprooting the trees or by breaking off the trunks.

It was also the general belief, in the region south of Tarryall Creek, that the death of many yellow pines was caused by some unusually dry seasons which have prevailed in recent years.

FOREST TREES IN THE RESERVES.

That this region once had a climate and forest flora differing considerably from that which at present exists is shown by the fossil remains of trees and other plants to be found at various places, and particularly easily accessible at Florissant, near the southeastern boundary line of the main body of the South Platte Reserve.

In the soft shale rock are found fossil leaves, fruit, and twigs of trees closely allied to the living species of redwoods or sequoias of California, to oaks, hornbeams, alders, walnuts, chestnuts, elms, ashes, sumachs, hollies, and other trees and shrubs. Fossilized stumps of prehistoric trees, apparently sequoias, still exist, although many have been destroyed or have been removed by collectors. About a mile south of Florissant one of these stumps is standing, with a frame work about it, and saws still in it, as evidence of the unsuccessful efforts of collectors to cut and remove it. The hardness of the fossilized wood rendered the cost of cutting so great that, after the expenditure of much money, the work of removal was abandoned. This stump was partly exposed by removing the accumulation of soil about it, and at present it is between 8 and 10 feet in height and about 50 feet in circumference at the ground. It is a standing witness to the fact that many thousands of years ago the meteorological and other conditions here allowed of

A. YELLOW PINE APPARENTLY KILLED BY MISTLETOE, PLUM CREEK RESERVE

B. ENGELMANN SPRUCE BLOWN DOWN BY WINDSTORM, LOST PARK, SOUTH PLATTE RESERVE

the growth of much larger trees and a greater variety than is now possible. In comparison with this ancient growth, the forest growth here to-day is small and insignificant, and compared with some of the present living forests of the Pacific coast in Washington, Oregon, or California the timber of these reserves would be regarded as little better than scrub or third-rate growth.

Within the actual limits of the three reserves, covering an area of nearly 2,000 square miles, the number of different species of trees now occupying the ground is much more restricted than is commonly supposed (Pl. IX). Within these boundaries there may be counted five species of pine, two spruces, two firs, Douglas spruce, two species of cedar (*Juniperus*), one species of oak, and four species of poplars—seventeen species in all. Of these the cedars are small, local, and scattered; the oak scarcely more than a shrub, specimens 20 feet high or 10 inches in diameter being rare; three of the poplars are very local and are usually found sparsely along creeks near the reserve borders, and have no commercial importance, while the fourth, though widely distributed, does not often grow to a size sufficient to make it of much present economic value.

PINUS PONDEROSA Laws. (Yellow pine, bull pine.)[1]

Of the pines within the reserves the most abundant, most widely distributed, and locally most valuable species is *Pinus ponderosa*, most commonly known as black-jack pine, but also passing under the local names of yellow pine, bull pine, black pine, etc. So far as observed, it here attains a larger size than any other tree, not excepting the red fir, which most closely approaches it in dimensions. The largest yellow-pine stumps or trees seen did not exceed 4 feet in diameter, and the tallest trees were not more than from 110 to 125 feet in height. These extreme proportions are exceptional, however, and the greater part of existing merchantable timber of this species ranges between 1 and 2 feet in diameter of trunk and 50 and 75 feet in height. As the timber is more or less open, the stems of the trees are usually well furnished with branches, so that the clear trunk is usually short, often furnishing but one free saw log 12 or 14 feet long, although the limbs are generally removed and two or even three saw logs are thus obtained. Trees of the larger sizes often have clear trunks for 50 feet, and as many as five or six saw logs, each 12 or 14 feet in length, are secured.

The relative proportions of size and age of such trees vary somewhat with the conditions under which they grow. Trees growing in coarse granite soil, on ground having a slight slope to the south and

[1] This yellow pine in the region under consideration is considered by some botanists as distinct from the type, and is known as *Pinus ponderosa scopulorum* Engelm.

lying at an altitude of about 8,500 feet, showed the following ages and dimensions, which represent a fair average.

A tree 100 feet high measured 38 inches in diameter at 5 feet from the ground. Trunk very branchy, furnishing only one saw log 12 feet long free from branches or knots, but altogether would furnish five logs of similar length, the topmost of which would measure a foot in diameter at the small end. Annual rings showed this tree to be about 270 years old.

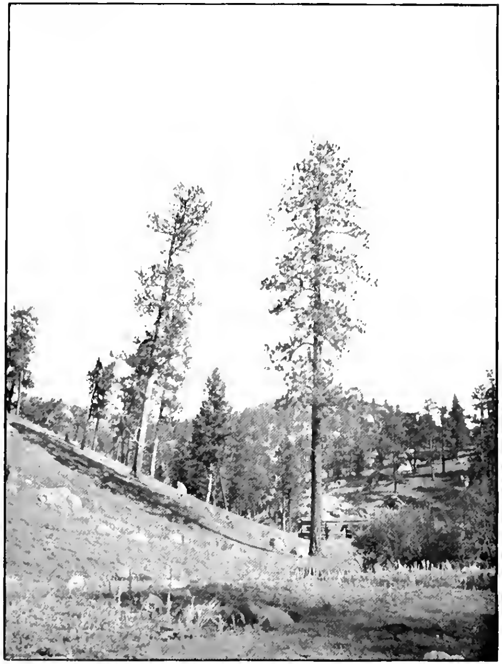
Another, 70 feet high, measured 15 inches in diameter at 5 feet from the ground and 12 inches in diameter at 40 feet from the ground. First 25 feet free from limbs excepting a few small, dead branches. Annual rings showed about 200 years of age.

Another of the same height and base diameter as the last was 8 inches in diameter at 40 feet from the ground and more branchy on its upper parts, and showed annual rings approximating about 160 years of age.

These measurements, taken from a considerable numoer, represent a fair average of the better class of trees where the timber is heaviest. Great quantities of trees are cut for sawmills, however, which do not produce more than one log of from 12 to 16 feet in length and from 12 to 16 inches in diameter, the remainder tapering too rapidly and bearing too many limbs to be considered of value. The activity of sawmills has removed nearly all trees above a foot in diameter in most of the territory under consideration except in a few of the least accessible localities farthest removed from a ready market. Where the timber has been cut over it is unusual to find any perfect large specimens fit for the sawmill remaining. Where large trees are left on such land it is usually because they have some defect, as having been struck by lightning, partially decayed, or having divided trunks.

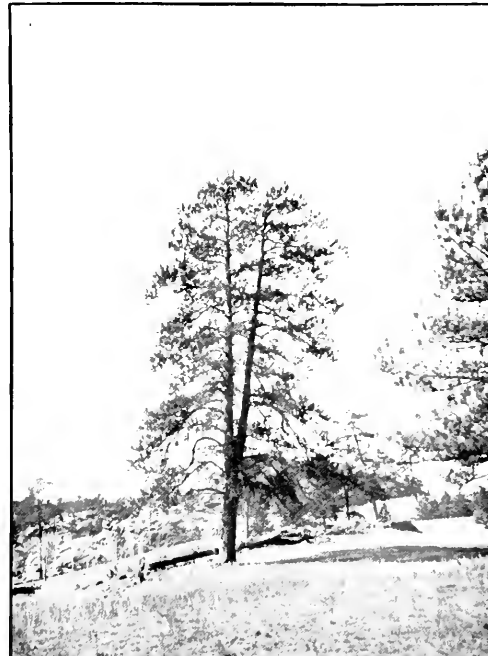
What to the eye of the botanist appears to be, and is considered, as one species is in this case divided by the lumberman into what he calls yellow pine and black pine, the former being most valued, having a wood lighter in weight and with less sapwood, while the latter is claimed to be of poor quality, to have much sapwood, and to be much heavier when green. Few lumbermen claim that they can always distinguish the two when standing, although it is asserted that the less valuable tree can be separated by the darker, rougher, thicker bark and greater abundance of large living branches. Somewhat similar distinctions are insisted upon by lumbermen of the white pine of the Eastern States. While our present understanding of them does not allow that they are specifically distinct, there is no doubt that the quality of the wood is affected by the age of the tree, rate of growth, soil, and other conditions.

The yellow pine is found from the lowest altitude in the reserves, which is under 6,000 feet, up to above 10,000 feet, where it is generally



A. YELLOW PINE, SOUTH PLATTE RESERVE.

About 100 feet high, 30 inches in diameter. Exceptionally large for the region.



B. YELLOW PINE WITH DIVIDED TRUNK, SOUTH PLATTE RESERVE.

About 70 feet high, 3 feet in diameter at 4 feet from ground.

supplanted by other species. In some sections it occurs almost alone, but as a rule the Douglas spruce is more or less plentifully associated with it, and occasionally it occurs mixed with the other pines and spruces. On the higher altitudes it does not appear so localized as on the lower, where it predominates on slopes facing the south, while the Douglas spruce is more plentiful on those facing the north. This is a marked feature in most of the canyons and gulches, which chiefly extend in an easterly and westerly direction.

The yellow pine is the prevalent tree over nearly all of the Plum Creek Reserve, and of the South Platte Reserve east of Craig Creek, the Tarryall Mountains, and Puma Hills. It does not occur in the Lost Park or Craig Park country, lying north of the Tarryall Mountains, although part of this ground lies nearly a thousand feet below the maximum altitude which the species reaches in other parts; and it is only occasionally found within and near the borders of the long, narrow arm of the reserve lying west of South Park, on the hills and buttes of which it occurs plentifully, and usually associated with Douglas spruce, blue spruce, and two other pines. It is a hardy and much-enduring tree, and will gain a foothold and grow on coarse, dry soils and sunny slopes on which other species do not seem able to become established or maintain their existence.

The yellow pine is chiefly sawed into lumber for various purposes, especially for rough building, mine timbers, etc. It is also cut for railroad ties, is used as fuel, and is an important tree in the development of the country in which it grows.

The lumber is coarse grained and is not durable when subjected to moisture. Its market value varies somewhat in price, according to quality, local demands, etc., but at the present time it usually sells for \$11 or \$12 per 1,000 feet, board measure, delivered at railroad stations.

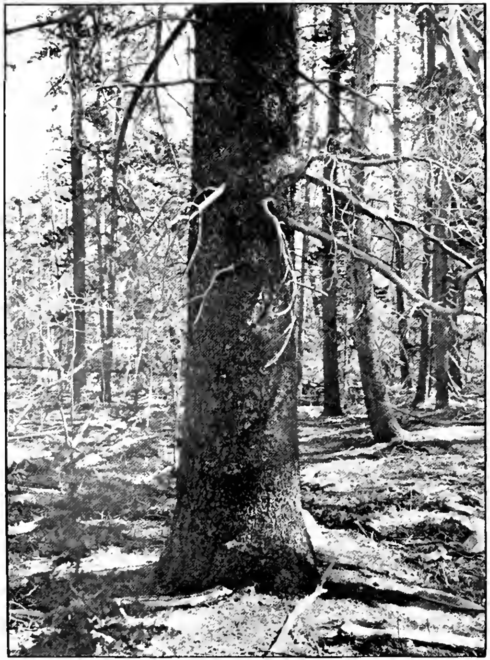
PINUS MURRAYANA Engelm. (Lodgepole pine, white pine, spruce pine.)

The pine of second importance in the reserves is the lodgepole pine, locally little known under that name, however, and more generally called white pine, occasionally spruce pine or tamarack pine, and at Alma passing as yellow pine. It is a smaller tree than the yellow pine (*Pinus ponderosa*), and specimens are not often found exceeding 2 feet in diameter of trunk or above 100 feet in height. It is sometimes found mixed with other pines or spruces, but its most characteristic growth is found in those areas where it occurs alone or greatly predominates over other species. It is apparently a tree of slow growth, especially when crowded, and will endure for many years without showing any very material increment of the wood. One out of a number of specimens, measured under fair average conditions of mixed open woods, growing on nearly level disintegrated granite soil southwest of Fairplay and at an altitude of about 9,000 feet, showed the following dimensions: Height, 65 feet; diameter, 4 feet from the ground, 17 inches; saw log furnished, 30 feet, the small end being 11½ inches in diameter, the remainder being very branchy and rejected. The annual rings showed about one hundred and sixty years of growth, the first fifty years showing much the greatest annual increment, the last fifty years with very thin annual rings and all sapwood. This fairly represents all those examined under similar conditions.

In the Lost Park region, north of the Tarryall Mountains, at an altitude of about 10,000 feet, two saw logs cut on a cold slope facing north measured, respectively, 12½ and 15 inches in diameter at the butt and showed 260 and 310 rings of annual growth. These trees were growing with Engelmann spruce on granite soil with slight humus. They represent about the best of their species fit for the sawmill. The height of such trees here usually varies from 60 to 75 feet, according as they may be growing with abundance of room, so as to produce many branches, or crowded by other individuals.

In other places, where the lodgepole pine occurs practically alone, a great number of individuals often spring up on a small area, forming a close and not easily penetrable growth while young, becoming more open with age and size by the death and decay of the weaker and smaller individuals. On such areas the annual growth is very slow, but the young trees show a remarkable power of shade endurance when overtopped by more sturdy or older individuals.

Many such areas were examined, and an idea of the general conditions may be given in a single example, in which four or five trees were crowded into a square foot, these trees varying from 4 to 8 feet high, 1 to 2 inches in diameter of stem, and with from 15 to 30 annual rings. Sometimes the stand of young trees is smaller and more dense, sometimes larger and proportionally more open, by the natural elimination of many weaker individuals. Nowhere are there any considerable areas of pure timber of this species large enough for cutting into lumber by sawmills. Most of the existing lodgepole-pine areas consist of slender, pole-like growths of varying sizes, but not often exceeding 6 or 8 inches in diameter or 50 feet in height. Wherever found of sufficient size, however, it is cut into rough lumber and generally sold mixed with yellow pine or spruce. Trees too small for the mill are often cut for mine timbers. A few years ago great quantities of all sizes were cut on territory lying to the north and west of the Kenosha Twin Cone Mountains, and converted into charcoal for smelting purposes. This industry is now abandoned in the region about the reserves, so that at present the lodgepole pine is of very limited commercial value and local use.



A. TRUNK OF LODGEPOLE PINE, 21 INCHES IN DIAMETER, SOUTH PLATTE RESERVE

B. ENGELMANN SPRUCE AT TIMBER LINE, SHEEP MOUNTAIN, NORTH SLOPE HORSESHOE GULCH, SOUTH PLATTE RESERVE

The range of this tree is much more restricted than that of the yellow pine. It appears to be uncommon and very local in the Pikes Peak Reserve, having been observed in any numbers only at its northern end. In the Plum Creek Reserve it is found in small numbers about Devils Head Mountain, but occurs in abundance, either nearly alone or mixed with other trees, from that point south and southwest to the Pikes Peak Reserve. Its distribution in the South Platte Reserve is peculiar and irregular. It is found more or less scattered through the Puma Hills, in the southern portion, sometimes occurring in small separate groves. It is found on the slopes of Freeman Peak, Green Mountain, and Stormy Peak, and is more or less scattered through the forest of the hills in the Lost Park and Craig Park region, lying north of the Tarryall Mountains. It is plentiful on the north slopes of the Platte River Mountains, and is, or was, the predominant species found on the slopes north and west of the Kenosha Twin Cone Mountains. It is distributed more or less plentifully through all the long, narrow, western arm of the South Platte Reserve.

When occurring in mixed growth its most common associate is Engelmann spruce, generally known here as white spruce. It is found most abundantly on the higher plateaus and on northerly slopes, and at altitudes ranging between 8,000 and 10,500 feet, descending below 8,000 feet and, exceptionally, reaching up to about 11,000 feet, but never extending to the highest timber line.

PINUS ARISTATA Engelm. (Range pine, bastard pine.)

This species does not appear to have any generally known popular name in the reserves, but in part is called range pine, pitch pine, or, as in the region about Tarryall Mountains, passes under piñon pine, a name more properly belonging to *Pinus edulis*, which occurs within the reserves only on a small area near Manitou. The names of foxtail pine and hickory pine, in some places applied to this tree, seemed to be rarely if ever used in this region. Pitch pine was the name applied to the tree about Alma, where it is common.

The range pine is never a large tree, rarely exceeding 40 or 50 feet in height, although the trunk is often stout in proportion to the height, frequently measuring 2 or 3 feet in diameter. It is usually of low, branching habit of growth, with many large limbs and rapidly tapering stems, which are often forked, so that it is not common to get more than one saw log of from 12 to 16 feet in length from a tree.

Much of this timber bears branches almost to the ground, or the clear trunks of a great majority of the trees are so short that not even an ordinary saw log can be obtained, so that this species is not often found among the logs which are to be cut by sawmills into ordinary lumber. It is frequently used for mine timbers, however, and for fuel.

In its distribution the range pine is found mostly on ridges, rocky ledges, and south slopes from about 8,000 feet altitude to timber line, which in these reserves averages about 11,500 feet, but in exceptionally favorable situations may extend, in twisted and dwarfed specimens, to 12,000 feet altitude. It is often the chief tree on the upper parts of southern slopes of many mountains, the upper northern slopes being chiefly occupied by Engelmann spruce. This division of the territory by the trees is often a marked feature in the canyons and gulches which lie in an easterly and westerly direction.

The range pine is common on the slopes of Pikes Peak, where it was originally discovered, and on the higher ridges in that region; it appears local and uncommon in the Plum Creek Reserve, it is plentiful through a large portion of the South Platte Reserve, particularly on the south slopes of unburned parts of the Tarryall Mountains and the mountains in the Lost Park region, continuing all through the branch of the reserve lying west of South Park. As a low, bushy tree it is scattered on the rocks and ridges of the open, uneven, or broken country lying within the reserve boundaries on the eastern side of South Park, as about Bordenville.

As would naturally be expected from the dry, poor, or rocky situations on which it most commonly grows, this pine is of very slow growth. Few opportunities were had to make measurements, but an idea of average relative size and age may be had from dimensions of a typical individual, under average conditions, which measured about 40 feet in height, 17 inches in diameter at 5 feet from the ground, and showed annual rings approximating 290 years of age. Individuals of larger diameter of trunk, and growing nearer timber line were undoubtedly of considerably greater age.

PINUS FLEXILIS James. (White pine, limber pine.)

This is the least common of any of the pines found in the reserves; it is less known or distinguished from other species by people living in the region, and it has least economic importance. Nowhere does it appear to be recognized by any general familiar name, although it is occasionally referred to as white pine; was also pointed out as sugar pine; and is said to pass under the name of bull pine. As a rule, however, it seems to be confounded with the range pine, with which it most commonly grows and to which it bears some general superficial resemblance.

In stature it is somewhat similar to the range pine; it has much the same kind of short, rapidly tapering trunk, often divided, and generally bearing many large limbs. The trunk is more free from lower branches and attains a larger diameter, however, than the range pine, and it more often makes good sawmill logs, although on account of the general scarcity of the tree its wood is not often seen in lumber piles.

A. RANGE PINE (PINUS ARISTATA) AT TIMBER LINE, PIKES PEAK, SOUTH SLOPE

B. LODGEPOLE PINE IN SOUTH PLATTE RESERVE

A little timber has been cut here—all under 10 inches in diameter.

While the white pine is nowhere abundant, it is quite generally scattered through most parts of the reserves, occuring from about the lowest levels, or between 6,000 and 7,000 feet, up to timber line, or about 11,500 feet, although it appeared to attain the latter altitude only occasionally, and was not seen to reach the extreme limits of stunted specimens of the range pine. It grows with the latter and with Engelmann spruce at timber line on the south and east slopes of Pikes Peak, and occurs here and there through most of that reserve, and appears to have been more than usually plentiful on that portion of it north of Ute Pass which was burned over about twenty years ago. It is scarce in the Plum Creek Reserve; and in the South Platte Reserve it is very irregular, but appears to occur most often through its extreme western arm.

Whenever of sufficient size and development of clear trunk, the white pine is sawed into lumber or used for mine timbers, but on account of its comparative rarity it is of very slight economic value in this region.

PINUS EDULIS Engelm. (Piñon, piñon pine, nut pine.)

This, the true piñon, or piñon pine, only occurs within the reserve limits in the vicinity of Williams Canyon, north of Manitou, under 8,000 feet altitude, where it is commonly mixed with *Juniperus monosperma* and *Juniperus scopulorum*. It is here a low, bushy tree, rarely more than 15 feet high, not often exceeding 12 or 15 inches in diameter, and with a very short or no clear trunk. It is locally valued for fuel, and in the Arkansas Valley, south and west of the reserves, it was formerly much cut and used in the manufacture of charcoal for smelting purposes.

PSEUDOTSUGA TAXIFOLIA (Lam.) Britton. (Red fir, Douglas spruce, red spruce.)

The tree generally known to botanists and dendrologists as Douglas spruce is in the reserves almost universally known as red spruce, sometimes red pine, and certain trees which contain a large proportion of sapwood are sometimes called bastard spruce by lumbermen. It is the red or yellow fir of the Pacific coast.

This tree has almost exactly the same range in the reserves as the yellow pine (*Pinus ponderosa*) with which it is usually found associated, sometimes one preponderating, sometimes the other, according to the peculiar local conditions and exposures. It grows well at the lower altitudes in the reserves, or at about 6,000 feet altitude, and the highest altitude at which it was noted was between 10,500 and 11,000 feet, on the south slopes of the Tarryall Mountains, near Mountaindale. The altitude reached here seems to be exceptional, however, for as a rule the upper limits of this species appeared to be about 10,000 feet, or occasionally 10,500 feet. Growing mainly under similar conditions the red fir appears to reach about the same dimensions, in this part of the country, as the yellow pine.

Trees with trunks 4 feet in diameter at the stump and 110 or 120 feet in height, with a clear trunk of 50 or 60 feet, are very rare and apparently never were common, even before the coming of sawmills. A trunk diameter of 2 feet at 3 or 4 feet from the ground and a total height of 100 or 110 feet, giving, perhaps, 60 feet of saw log, the upper 20 feet or more of which bears branches, the small end about or little less than a foot in diameter, is considered fine timber of this species in this region. Trees of this extra size are very exceptional, however, and are found in few localities and on limited areas, either alone or so intermixed with poorer material or other species that the amount of lumber per acre on any given square mile or quarter section is not great, probably never exceeding an average of 2,000 feet to the acre. Wherever easily and profitably accessible, nearly all trees of suitable sizes have been cut for the sawmill or for railroad ties.

Most of the Douglas spruce which remains on the reserves consists of rather small, much-branched trees with not more than 12 or 15 feet of clear trunk, or those in which some defect unfits them for profitable lumber purposes, or they are under 8 inches in diameter and therefore not useful either for sawmill lumber or for making of railroad ties.

On the lower altitudes and along canyons and gulches the red fir is found mixed with blue spruce as well as yellow pine, and in its upper limits it is often scattered among Engelmann spruce and lodgepole pine. It occurs throughout the Pikes Peak Reserve up to about 10,000 feet altitude, and is commonly mixed with other species over all the Plum Creek Reserve, particularly in gulches and on northern slopes.

The Douglas spruce is distributed through the main body of the South Platte Reserve, but, like the yellow pine, it seems strangely absent from the Lost Park region lying north of the Tarryall Mountains and east of South Park, although the lower part of this region has an altitude decidedly lower than the species generally reaches; and on the long narrow extreme western arm of this reserve it is found only at irregular intervals near the edge of the eastern slope adjoining South Park, upon the low hills and buttes of which it occurs, generally small in size, and mixed with yellow pine and blue spruce.

The best trees yet uncut by lumbermen are found at altitudes of from 7,000 to 8,500 feet, on the ground drained by Wigwam Creek and Lost Park or Goose Creek, extending 4 or 5 miles back from their junctions with South Platte River; and on the nearly opposite slopes of this river in the southwest corner of the Plum Creek Reserve, southwest of Thunder Butte. In these places, however, the forest covering is thin and there is a preponderance of other kinds of trees, or of those too small for any present use.

A. WHITE PINE (PINUS FLEXILIS), EASTERN SLOPE OF PIKES PEAK.

Living tree, 18 inches; dead tree, 24 inches in diameter.

B. ENGELMANN SPRUCE ON BRECKENRIDGE PASS, WEST SLOPE.

Largest trees 80 or 90 feet high, trunks 3 feet in diameter. Above 11,000 feet altitude.

As a rule the Douglas spruce seems to maintain about the same relative rate of growth and increase in size as the yellow pine when growing together and under similar conditions.

On north slopes and decayed granite soil, in the favorable localities just mentioned, a number of red firs were measured and their ages ascertained. A tree growing without having been much crowded measured 58 feet in height, was 17 inches in diameter at 3 feet from the ground, and the small end of the second saw log, cut at 26 feet from the large end of the first log, was 12 inches in diameter. The remaining 32 feet of length bore many large green branches and was rejected by the lumberman. The annual rings showed this tree to be about 175 years old.

Another having a total height of 75 feet was 18½ inches in diameter at 3 feet from the ground, 12 inches in diameter at small end of log 30 feet in length, the remaining 45 feet being rejected on account of branches. Annual rings showed about 180 years of growth.

Douglas or red spruce is considered more desirable for lumber and railroad ties than yellow pine, but although the railroad ties made from Douglas spruce generally command 10 cents each more than those made from pine, the sawmills, when cutting the logs into boards and other building lumber, rarely separate the spruce and pine, but all are mixed and sold at the same price per thousand feet. This is undoubtedly in part due to the fact that the lumber is largely used locally, or in mining camps, for the construction of rough, hastily-erected, and cheap buildings, the lowest-priced lumber being sought; and also because the Douglas spruce fit for the sawmill is so scattered and mixed with pine that any slight difference in price it might command would not pay for sorting and separating at the mills.

It is the principal tree used in constructing bridges over creeks and streams, being more durable in contact with water than most other timbers locally available.

PICEA ENGELMANNI Engelm. (Engelmann spruce, white spruce.)

The Engelmann spruce is almost universally called white spruce throughout the reserves. It is the most abundant tree on all the uppermost forest ranges, and to-day would probably furnish more ready sawmill timber than any other species within the territory under consideration. It often grows as almost pure spruce woods, but commonly some lodgepole pine, range pine (*P. aristata*), or alpine fir (*Abies lasiocarpa*) is found mixed with it.

Often extending down cool northern mountain slopes and following cold canyons and gulches in small numbers to 6,000 or 7,000 feet altitude it is most abundant, and seems most at home. It reaches its best development at an elevation between 10,000 and 11,500 feet covering the tops of mountains under timber line and forming a belt around the highest, often furnishing fair sawmill timber up to from 11,500 to 11,700 feet, and extending in more or less dwarfed or stunted form, according to the exposures, to the highest limit reached by trees in the reserves. As a rule this appears to be between 11,700 and 11,800 feet, but in some situations straggling groups or individuals are found at about 12,000 feet altitude.

While the range pine (*Pinus aristata*) often chiefly occupies rocky southern slopes opposite the northern slopes, which are covered by Engelmann spruce, the latter species also appears to occupy most intermediate locations, and often crowds the pine from the extreme upper limits.

In its best condition, as found in these reserves, the Engelmann spruce is a tree with regularly-tapering stem, sometimes 110 to 120 feet high, and with a trunk over 3 feet in diameter at 3 or 4 feet from the ground. Commonly it ranges between 70 and 80 feet in height and 8 or 10 inches to 2 feet in diameter, although specimens 3 feet in diameter and much shorter in proportion are found near timber line. Branches, living and dead, are generally borne from near the ground to the top, so that there is practically no clear trunk, or only a few feet of it, this condition prevailing even where the trees are growing comparatively close together. The branches are slender and generally not more than 6 or 7 feet long and markedly depressed, so that besides offering comparatively little resistance to winds, to which the trees are much exposed, the drooping branches carry very little of the snow which falls upon them.

As might be expected on the poor granite soils on which the Engelmann spruce generally grows, and the cool high altitudes at which it reaches its best development, where frosts are common and snows not very rare throughout the summer, the growth of the trees is slow, and a great many years are required to produce the best of the sawmill timber now found. Many trees and logs were measured and the ages ascertained from specimens growing in different sections, and the results showed a fairly uniform rate of growth and increment.

In the Lost Park region, on a northern slope, in coarse granite soil, and at about 10,000 feet altitude, one of the best trees seen cut for lumber measured 110 feet in height (the top being dead), was 28 inches in diameter at 3 feet from the ground and had clear annual rings showing about 275 years of growth. This tree gave five good saw logs of a total length of 72 feet, the first three each 16 feet and the last two 12 feet in length, and measuring respectively 24, 21, 19, 16¼, and 12½ inches in diameter, at the small end, giving upward of 1,200 feet of lumber. At the top of the last log, 72 feet from the butt end or 75 feet from the ground, annual rings showed 140 years of growth, so that the remaining 35 feet of height had developed in about 135 years.

A. ENGELMANN SPRUCE TRUNK OVER 3 FEET IN DIAMETER, BRECKENRIDGE PASS WEST SLOPE

Altitude above 11,000 feet

B. ENGELMANN SPRUCE AT TIMBER LINE, NORTH SIDE OF PIKES PEAK

Altitude nearly 12,000 feet.

Another tree, with its top broken and decayed, showed 325 clear annual rings of growth and gave three saw logs; the first 12 feet long, 35½ inches in diameter at large end and 28 inches at small end; the second 16 feet long and 25 inches in diameter at small end; and the third also 16 feet long and 22 inches in diameter at small end. Up to about 200 years the annual rings were of fairly uniform thickness, but largest in the second half of the first century. After 200 years the rings become distinctly thinner with the age of the tree. Trees of the dimensions of these two are exceptional, the average being much smaller.

Another specimen, cut near the last, measured 12½ inches in diameter at the stump and 68 feet in total height, and annual rings showed it to be about 225 years of age. Thirty feet of saw log was taken from it, the small end measuring 8½ inches in diameter, the remaining 35 feet being rejected as too small and bearing too many branches for profitable lumber.

Near Boreas, on Breckenridge Pass on the northern slope, at an elevation of 11,500 feet, the larger trees did not measure more than from 60 to 70 feet in height, although at 3 feet from the ground some of the trunks measured over 2 feet in diameter and showed as much as 340 annual rings of growth.

All of these trees were growing on a coarse rocky or granite soil, where no traces of former forest fires were to be found, and where there was an accumulation of several inches of humus. The trees on Breckenridge Pass probably receive more moisture from westerly winds than those in Lost Park.

Most of the timber land in the reserves which does not show any trace of damage by fire is situated at the higher altitudes where this spruce occurs, but the areas which have had such immunity are generally not large.

The Englemann spruce is sawed into much the same class of lumber, and is mainly used for the same purposes and commands about the same prices as the yellow pine and Douglas spruce, although it does not appear to be much cut for railroad ties. It was formerly used in making charcoal, and recently has been cut for the manufacture of paper pulp. Being, as a rule, the least accessible of all the good timber trees, it has been the last to be attacked by lumbermen, and consequently there is more of it of a size fit for lumber standing on a given area than of any other species. It is found throughout most of the Pikes Peak Reserve and is particularly abundant on the higher mountains and slopes around Pikes Peak, especially to the south and west, and, although the principal tree, it does not occur of large size over any considerable areas unbroken by fire, the ax, or by predominance of other kinds of trees which occur on exposures peculiarly suited to them. It is still plentiful near Lake Moraine and the Seven Lakes on the south, and in the so-called Black Forest, occupying a narrow belt to the north and west. It is uncommon in the northern part of the reserve; and so little of it is to be found in the Plum Creek Reserve that it is there of no economic importance.

In the eastern part of the South Platte Reserve it is rarely seen within 4 or 5 miles of the South Platte River. It is found on the Puma Hills in the southern part, and the Tarryall Mountains in the central part, and is most abundant to the north of the latter, over the region covered by the Kenosha and Platte mountains, with the intervening Lost Park and Craig Park. Here it is the prevailing tree, although it is often mixed with lodgepole pine, the so-called range pine (*Pinus aristata*), and occasionally with alpine fir (*Abies lasiocarpa*).

In this area it forms the only considerable body of original timber remaining within the limits of any of the reserves, although even here it has not been exempt from the ravages of fire, and the lumberman has been at work in the heart of it. This spruce is also found through the long western arm of the reserve, west of South Park, although unfortunately the best and most valuable forested areas are chiefly outside the western boundaries of the reservation.

PICEA PARRYANA (André) Parry (PICEA PUNGENS, Engelm.). (Colorado blue spruce.)

This tree is found passing under various local names, among them blue spruce, silver spruce, white spruce, fan-leaf spruce, and water spruce. Two or three names are sometimes applied to different individuals when growing side by side, according as they may vary in color of foliage, peculiarities of branching, etc.

In its best condition, as found in these reserves, the blue spruce may attain a height of 110 or 120 feet and a diameter of trunk of about 3 feet near the base. It is a more horizontally branched, broader spreading, more symmetrical tree than the Engelmann spruce and grows much more rapidly, especially in the first few decades of its development.

An example of the rate of growth may be given from a specimen on the banks of Tarryall Creek, near Farnham's ranch, at about 9,000 feet altitude, which measured 90 feet in height and 31 inches in diameter at 4 feet from the ground, and which the annual rings of growth showed to be between 180 and 200 years old.

On exposed situations, when the species grows old, the branches often have a straggling, stunted aspect, which gives the trees anything but the beautiful, symmetrical appearance which they have in youth, in sheltered places, or in cultivation.

As a rule there is little of clear trunk even where the trees are comparatively crowded among other species.

The blue spruce is peculiarly uneven in its distribution, is confined to the lower altitudes, and is usually found along rivers and creeks or

A. BLUE SPRUCE (PICEA PARRYANA) NEAR BUFFALO SPRINGS, SOUTH PARK

B. CHARACTERISTIC GROWTH OF ASPEN IN PIKES PEAK RESERVE WHERE FOREST HAS BEEN DESTROYED AND GROUND BURNT OVER MORE THAN ONCE

Prostrate trees burnt fifteen or twenty years before.

A. BLUE SPRUCE (PICEA PARRYANA) AT CASSELLS, SOUTH PLATTE RESERVE

Three feet in diameter at 4 feet from ground; 90 to 1[illegible] feet high

B. BLUE SPRUCE AND ASPEN (POPULUS TREMULOIDES), PLUM CREEK RESERVE

Aspen 10 inches in diameter; about [illegible]

where more than the average amount of moisture is obtained from the soil, although it occurs also on the north slopes of some low hills and ridges. It commonly occurs over the same territory occupied by the yellow pine and Douglas spruce, which usually grow on the slopes, while the blue spruce more closely follows the water courses. As a rule, it seems to range between 6,000 feet and 9,000 feet in altitude, but sometimes reaches fully 1,000 feet above the latter elevation.

It never occurs as pure forest, and is nowhere sufficiently abundant to be of commercial value, generally being scattered among other species.

It is found scattered along the creeks and gulches of the lower parts of the Pikes Peak Reserve, crossing it through Ute Pass, and occuring here and there over the lower unburned parts to the north. It is to be met scattered along creeks through the Plum Creek Reserve, and all around the main body of the South Platte Reserve, being more than usually plentiful in the southern portion, ascending Lost Park Creek almost to Lost Park itself, and crossing the reserve diagonally by way of Tarryall Creek from the South Platte River to South Park. It occurs at intervals along the eastern margin of the narrow western arm of the reserve, especially near its southern end, where, in spots, it most nearly appears as the prevailing growth. It is commonly scattered over the hilly portion of South Park lying between the two parts of the reserve.

Its altitudinal distribution is peculiar and variable according to locality and other conditions. As examples it may be mentioned that in the canyons east of Pikes Peak 8,500 to 9,500 feet seems to be the upper limit; along the North Branch of the South Platte it disappears a little above Webster, at about 9,000 feet altitude, and its place is taken by the Engelmann spruce; it exceeds this altitude when following the course of Tarryall Creek to South Park; is found at an elevation of fully 9,800 feet to the west of the town of Como; while to the south, within a mile or two of Platte Station or Rich's ranch, it is found reaching up to quite 10,000 feet altitude before it is entirely supplanted by Engelmann spruce and other trees.

The wood of the blue spruce is generally coarse and otherwise of poor quality. Nevertheless, in this region, where rough timbers are chiefly in demand, wherever found of sufficient size, it is, with the yellow pine and Douglas spruce, usually sawed into boards and other classes of lumber and sold mixed with the better kinds.

Young plants showing the most blue or glaucous foliage are sometimes collected and shipped to nurserymen to be grown for ornamental purposes. Plants growing side by side show much variation in foliage, many having an ordinary green coloring, while others are very strikingly glaucous or blue.

ABIES CONCOLOR (Gord.) Parry. (Colorado white fir, balsam fir, blue fir.)

This tree may be regarded as rare and very local in the reserves. It was not observed anywhere to reach an altitude greater than about 8,500 feet; and its best developement was attained along water courses or on adjacent cold north slopes, where it was sometimes found 70 or 80 feet in height and with a trunk 2 feet or more in diameter.

When not crowded it is usually a beautifully symmetrical tree, conical in outline, with regular horizontal branches. It is most often to be seen along creeks and gulches on the eastern slopes of the Pikes Peak and Plum Creek reserves; and is apparently a very rare tree in the South Platte Reserve, not being found at all in the main body or extreme western portion of it.

It is not of any special economic importance in this region, although, whenever large enough, it may be cut, with other species, for the sawmill.

ABIES LASIOCARPA (Hook.) Nutt. (ABIES SUBALPINA, Engelm.). (Alpine fir, balsam.)

While the preceding species is only found at the lower levels, the alpine fir reaches up to the average timber line; also extending well down the mountain sides on cold northern slopes, but apparently not meeting or mingling with *Abies concolor*.

It is also rare and local, and nowhere occurs in sufficient numbers to be taken into commercial account. It is usually found scattered among Engelmann spruce, and is also sometimes found associated with lodgepole pine. But it is by no means always found wherever these trees occur.

It is most often to be seen in the mountainous region between the Tarryall Mountains and the North Branch of the South Platte River, and on the high range of the narrow western arm of the South Platte Reserve.

It is usually a smaller tree, with decidedly shorter branches than *Abies concolor*. It is occasionally 70 or 80 feet high, with a trunk 2 feet in diameter, the height of the tree diminishing as timber line is approached, as is the case with Englemann spruce.

At Boreas, on Breckenridge Pass, at fully 11,500 feet altitude, an average tree of this fir measured 53 feet in total height, was 15½ inches in diameter at 3 feet from the ground, and 12 inches in diameter at 20 feet from the larger end of the log.

It showed 185 annuai rings of age, the first 100 rings of nearly uniform size, the remainder appreciably smaller with the advancing age of the tree.

When large enough the alpine fir is sometimes cut with the spruce for lumber or paper pulp.

JUNIPERUS SCOPULORUM Sargent. (Cedar.)

This tree sometimes passes in the same locality under the names of juniper, cedar or red cedar, and white cedar, the latter name being applied to trees with unusally glaucous foliage.

It is local and never abundant in the reserves, usually growing scattered on the most rocky ledges or soils, and apparently chiefly limited to altitudes under 9,000 feet, or less than the general range of the yellow pine.

It is rarely found 25 feet in height, and the trunk is usually very much branched to the base or has a divided stem. It is of very slow growth and very tenacious of life. Many individuals are in part dead, probably mainly by reason of unusually dry seasons, the trees being situated on the driest and most exposed situations.

This cedar is found on rocky, dry hills and rocks in parts of the lower levels of all of the reserves, but is nowhere sufficiently abundant to make it of much commercial importance. It is much prized and used locally, however, its durability under nearly all conditions being fully recognized and appreciated.

JUNIPERUS MONOSPERMA (ENGELM.) Sargent. (One-seed juniper, cedar, red cedar.)

This juniper or cedar is generally at once distinguished from the preceding species by having more rigid twigs and darker green foliage, never showing the glaucous coloring characteristic of *Juniperus scopulorum*. It is found near Manitou with *J. scopulorum* and piñon pine (*Pinus edulis*), and rarely at several other points near the reserve boundaries, but it does not grow to the same altitudes on the hills as *J. scopulorum*, being practically confined to very nearly the same limits as the piñon pine.

The one-seed juniper appears to grow to about the same size as the other, and is used for similar purposes; but it is so rare in the territory under consideration as to be practically not deserving more than mere mention.

POPULUS TREMULOIDES, Michx. (Quaking asp, trembling aspen.)

This is the only deciduous tree which occurs plentifully over any considerable area of the reserves. It is found in almost all parts, from the low levels near the reserve borders up to 10,500 or 11,000 feet altitude, and even higher in favored localities and in small specimens. It may be seen at these higher altitudes on the slopes about Pikes Peak, and also in other places.

It commonly occurs most abundantly over areas that have been swept by forest fires, and if the ground gives evidence of having been burned over more than once the growth of "quaking asp" is usually proportionately more dense. It is also found to a limited extent in open woods which show no trace of fire since white men came into the country. It reaches its best development along streams or in places where there are springs or more than the usual amount of moisture, but, in smaller size, it grows on ordinary levels, slopes, or mountain sides, being, as a rule, less abundant on very warm southern slopes than in other situations.

Under most conditions in which it is found it is rarely more than 25 or 30 feet high, with a stem 5 or 6 inches in diameter, and commonly it is so small and poorly grown as to be practically worthless under present conditions and demands. In a few favored situations it sometimes attains a height of 60 or 70 feet, with a long clean trunk over a foot in diameter at 4 or 5 feet from the ground. Such trees, however, are exceptional.

Wherever large enough the quaking asp has lately been cut for shipment to Denver for the manufacture of excelsior and also of paper, but the quantity obtainable for this purpose is so limited as to be totally exhausted with the shipment of a few carloads.

The vast areas of smaller timber furnish at present only firewood and fencing. For the latter purpose it has been found that fence rails made of quaking aspen, stripped of the bark, will last for many years, rails in use for twenty years being yet perfectly durable. In the moist atmosphere of the Eastern States these would probably be decayed and useless at the end of two or three seasons. It is not found so enduring for fence posts, however, and for this purpose it is usual to employ either cedar, Douglas spruce, or yellow pine.

The remarkable power of the quaking aspen to spring up and partially cover the ground soon after a forest fire is largely due to the fact that many plants exist in a more or less suppressed condition through these open woods. The roots are very widespreading and mostly near the surface of the soil, and when the ground is burned over adventitious buds produce stems at irregular intervals along these roots, so that from a single original plant there may spring up a colony of stems extending for many feet around it.

POPULUS ANGUSTIFOLIA James. (Cottonwood, narrow-leaved cottonwood.)

This tree is only found along rivers and creeks, sometimes ascending these streams to between 9,000 and 10,000 feet altitude. It is nowhere abundant, occurring only as scattered individuals or groups, and on account of its scarcity it is of little economic value in and about the reserves, excepting that it is planted for shade. It may be considered as the largest deciduous tree found in this region, but the best specimens seen hardly exceeded 2 feet in diameter of trunk and 50 feet in height.

POPULUS BALSAMIFERA Linn. (Balm of Gilead poplar, cottonwood.)

This tree is found along streams in and about the reserves up to 10,000 feet or greater elevation, but it is nowhere common or of any extensive use. It sometimes attains about the same size as the narrow-leaved cottonwood, to which it often bears a close general resemblance.

POPULUS DELTOIDES Marsh. (P. MONILIFERA Ait.)

The broad-leaved cottonwood, so common along creeks and rivers on the plains, did not appear to be actually indigenous within the limits of the reserves, although it occurs in the vicinity of them and is planted for shade and other useful purposes.

Populus acuminata Rydberg, was seen only about Colorado Springs and Manitou, where a few individuals may be found. In all specimens seen they showed features which suggested a hybrid between the broad-leaved and the narrow-leaved cottonwoods.

PIKES PEAK FOREST RESERVE.

BOUNDARIES.

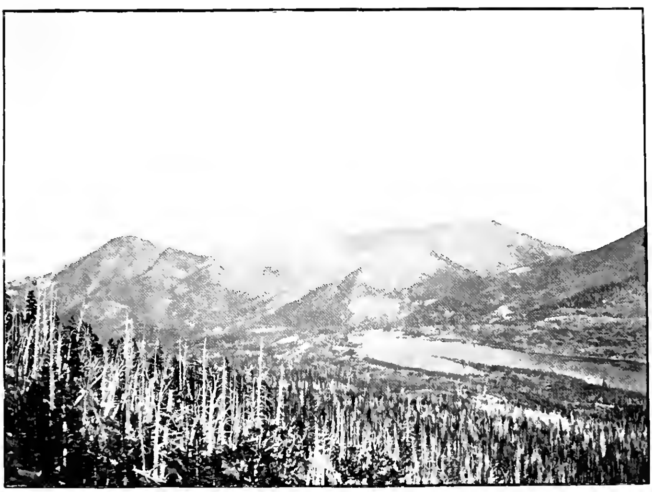
The boundaries of this reserve, as established by Executive order of March 18, 1892, supplementary to that of February 11, 1892, are as follows:

Beginning at the northeast corner of section four (4), township eleven (11) south, range sixty-seven (67), west of the sixth (6th) principal meridian; thence westerly along the second (2nd) correction line south, between townships ten (10) and eleven (11) south, to the northwest corner of section six (6), township eleven (11) south, range sixty-eight (68) west; thence southerly along the range line between ranges sixty-eight (68) and sixty-nine (69) west, to the southwest corner of section eighteen (18), township thirteen (13) south, range sixty-eight (68) west; thence westerly along the section line between sections thirteen (13) and twenty-four (24), fourteen (14) and twenty-three (23), fifteen (15) and twenty-two (22), sixteen (16) and twenty-one (21), seventeen (17) and twenty (20), and eighteen (18) and nineteen (19), to the northwest corner of section nineteen (19), township thirteen (13) south, range sixty-nine (69) west; thence southerly along the range line between ranges sixty-nine (69) and seventy (70) west, to the southwest corner of section thirty-one (31) of said township; thence easterly along the township line between townships thirteen (13) and fourteen (14) south, to the quarter section corner on said township line between section thirty-five (35), township (13) south, range sixty-nine (69) west, and section two (2), township fourteen (14) south, range sixty-nine (69) west; thence southerly through the middle of sections two (2), eleven (11), and fourteen (14), township fourteen (14) south, range sixty-nine (69) west, to the quarter section corner on the section line between sections fourteen (14) and twenty-three (23) of said township and range; thence easterly along said section line to the northeast corner of section twenty-three (23) of said township and range; thence southerly along the section line to the quarter section corner on said line between sections twenty-three (23) and twenty-four (24) of said township and range; thence easterly through the middle of section twenty-four (24) to the quarter section corner on the range line between section nineteen (19), township fourteen (14) south, range sixty-eight (68) west, and section twenty-four (24), township fourteen (14) south, range sixty-nine (69) west; thence southerly along said range line to the southwest corner of section thirty-one (31), township fifteen (15) south, range sixty-eight (68) west; thence easterly along the third (3rd) correction line south between townships fifteen (15) and sixteen (16) south to the southeast corner of section thirty-four (34), township fifteen (15) south, range sixty-seven (67) west; thence northerly along the section line between sections thirty-four (34) and thirty-five (35), twenty-six (26) and twenty-seven (27) to the point for the quarter section corner on the section line between sections twenty-two (22) and twenty-three (23), township fifteen (15) south, range sixty-seven (67) west; thence westerly to a point for the legal center of section twenty-one (21) of said township and range; thence southerly to the southwest corner of the southeast quarter of section twenty-eight (28) of said township and range; thence westerly along the section line between sections twenty-eight (28) and thirty-three (33), twenty-nine (29) and thirty-two (32), thirty (30) and thirty-one (31) to the northwest corner of section thirty-one (31) of said range and township; thence northerly on the range line between ranges sixty-seven (67) and sixty-eight (68) west to the southwest corner of section six (6) of said township and range; thence easterly along the section line to the southeast corner of section six (6) of said township and range; thence southerly along the section line to the southwest corner of section eight (8) of said township and range; thence easterly along the section line to the southeast corner of section ten (10) of said township and range; thence northerly along the section line between sections ten (10) and eleven (11), two (2) and three (3), township fifteen (15) south, range sixty-seven (67) west, to the northeast corner of section three (3) of said township and range; thence westerly along the township line between townships fourteen (14) and fifteen (15) south to the northwest corner of section three (3), township fifteen (15) south, range sixty-seven (67) west; thence northerly along the section line between sections thirty-three (33) and thirty-four (34), twenty-seven (27) and twenty-eight (28), twenty-one (21) and twenty-two (22) to the northeast corner of section twenty-one (21), township fourteen (14) south, range sixty-seven (67) west; thence westerly along the section line between sections sixteen (16) and twenty-one (21), seventeen (17) and twenty (20), eighteen (18) and nineteen (19) to the northwest corner of section nineteen (19) of said township and range; thence northerly along the range line between ranges sixty-seven (67) and sixty-eight (68) west to the northeast corner of section one (1), township fourteen (14) south, range sixty-eight (68) west; thence easterly along the township line between townships thirteen (13) and fourteen (14) south to the southeast corner of section thirty-three (33), township thirteen (13) south, range sixty-seven (67) west; thence northerly along the section line between sections thirty-three (33) and thirty-four (34), twenty-seven (27) and twenty-eight (28), twenty-one (21) and twenty-two (22), fifteen (15) and sixteen (16), nine (9) and ten (10), and three (3) and four (4) of townships thirteen (13), twelve (12) and eleven (11) south, range sixty-seven (67) west to the place of beginning.

TOPOGRAPHY AND DRAINAGE.

Of the 184,320 acres contained within the Pikes Peak Reserve, that having the lowest altitude consists of a small corner near Manitou with an elevation of between 6,000 and 7,000 feet above sea level. Almost the whole of the Pikes Peak Reserve is composed of rugged

A VIEW AT SEVEN LAKES, PIKES PEAK RESERVE LOOKING SOUTH



B VIEW LOOKING EAST TO LAKE MORAINE, SHEEP MOUNTAIN, AND CAMERON CONE FROM SLOPES OF PIKES PEAK.

hills and mountains which attain an extreme elevation in Pikes Peak itself, the height of which is 14,108 feet. To the south and southeast of Pikes Peak are numerous mountains and ridges between 11,000 and 13,000 feet in elevation; a very small portion is below 8,500 feet, and probably the average altitude exceeds 10,000 feet. To the north of Pikes Peak the land falls much more abruptly, and most of the territory lying in the reserve between the Peak and the Plum Creek Reserve ranges between 8,000 and 9,500 feet in altitude, the highest points not exceeding 10,000 feet.

The soil is generally a coarse, broken, or decayed granite, among which are distributed many ledges, rocks, or bowlders. There is little humus or loam, and whatever there may be is generally accumulated in hollows, along creeks, or in small areas of forest which show no trace of fire. In the Lake Moraine vicinity there is a good deal of deep muck, the accumulation of many centuries.

Several small creeks have their sources in the Pikes Peak Reserve, most of them falling to the east or west into larger streams, which in turn empty into the South Platte River on the north or the Arkansas River on the south, most of the water falling into the latter stream. The most important of these creeks is Fountain Creek, which rises in the western part, where it is known as Catamount Creek, and, passing across the center of the reserve, is joined by Monument Creek near Colorado Springs and falls into the Arkansas River at Pueblo. It is fed by a number of small tributaries, among them Ruxton Creek, which carries the waters flowing from the east of Pikes Peak and joins Fountain Creek near Manitou. The waters of Ruxton Creek are used both for power purposes and water supply for the towns below.

The southern end of the reserve is chiefly drained by Beaver Creek and its tributaries, and Cheyenne Creek and its branches carry off the water from a comparatively small area in the southeastern part.

There are no large bodies of water on the reserve. The largest, known as Lake Moraine, is less than 100 acres in area, and is now, in fact, an enlarged artificial reservoir, forming part of the Ruxton Creek water system.

The small bodies of water known as the Seven Lakes are above, and are separated from Lake Moraine by a high divide, and have Beaver Creek, which flows southward, for their outlet. These lakes are situated at an altitude of about 10,500 feet, are of various depths, and altogether, when full, may cover a hundred or more acres in area.

A tunnel, known as the Strickler tunnel, is in process of construction, with the object of drawing some of the waters near the head of Beaver Creek into Lake Moraine in order to increase and perpetuate the water supply for Colorado Springs and other places below. In its fall of several thousand feet the water will be utilized to furnish power for various purposes.

Palmer Lake, a small artificial reservoir in the northeastern corner of the reserve, is situated outside the mountain region, so that it is of no special importance in relation to the reserve proper.

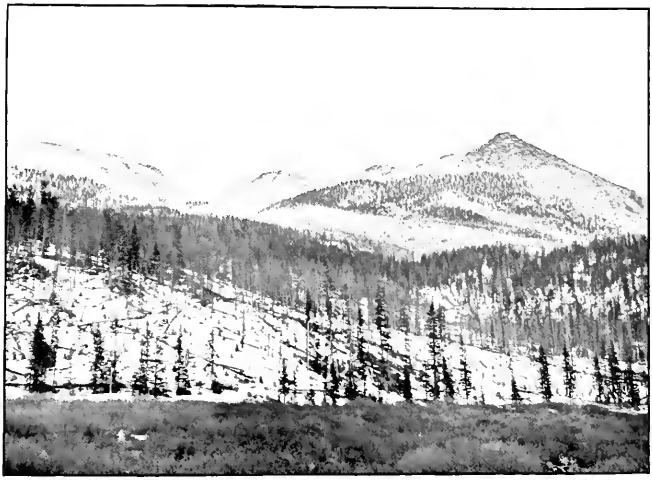
Considering the ranching, manufactures, and especially the large transient and permanent health-seeking population at Colorado Springs, Manitou, and other places along the eastern slope of this reserve, the importance of preserving a pure and undiminished water supply can not be overestimated; and, as this purest water comes from the higher mountains in the vicinity of and including Pikes Peak, every means should be taken to preserve it from damage of any sort.

Among the chief sources of the streams are the great snowdrifts above timber line, which accumulate in winter in deep gulches or hollows, and, slowly melting in summer, still exist on the north or shaded sides of the mountains when they are replenished by the snows of the succeeding autumn and winter.

TIMBER.

It is well known in mountainous regions that a constant and equable distribution of the water in summer is greatly helped by a good forest covering of the upper slopes and valleys, the effect being to cause a more gradual melting of snow where shaded and checking the water from precipitately rushing to streams below, as is generally the case on denuded ground. Unfortunately there are no very large continuous forest areas on this reserve, fire and the ax having removed the best portion of the timber, so that there is little of the primeval forest remaining or which does not show molestation by man. The best of the remaining timber is found in a narrow belt near Glen Cove, northwest of Pikes Peak, in the so-called Black Forest, to the west of Glen Cove, and perhaps 3 or 4 square miles in irregular patches and very variable density, lying south of Pikes Peak and mostly to the west of Lake Moraine and the Seven Lakes. Here and there, as near the Halfway House and a few other favored points near the line of the Manitou and Pikes Peak Railway, groves of a few acres of fine trees may be found, but these are exceptional. As a rule the best remaining timber is on the least accessible, although not inaccessible, slopes.

A considerable portion of the Black Forest district, situated between Glen Cove and Midland Station, lies outside the reserve boundaries. It has nearly all been cut over and the best of the timber taken out, although much still remains of sufficient size for immediate use. The activity of sawmills is indicated by numerous abandoned sawmill sites (or sawmill "settings," as they are called locally) which are found along the creeks. In June, 1896, fires destroyed a considerable portion of the living timber, and there was strong suspicion that the flames were started by lumbermen in order that their operations might come within



A BLACK FOREST LOOKING SOUTH TO SENTINEL POINT, WEST OF PIKES PEAK, MUCH CUT OVER AND BURNT

B RASPBERRY MOUNTAIN (CATAMOUNT HILL) AND PIKES PEAK, LOOKING EAST ON HAYDEN DIVIDE ROAD ABOUT 1 MILE SOUTH OF DIVIDE STATION

A. VIEW LOOKING SOUTH-SOUTHEAST FROM SLOPES OF PIKES PEAK TO HILLS SOUTH OF LAKE MORAINE

B. ENGELMANN SPRUCE IN PIKES PEAK RESERVE

Burnt probably over fifty years ago, enough old trees escaping to seed the ground; the old trees [illegible] out

the provision allowing dead timber to be removed from the Government reserves.

The timber near Lake Moraine has mostly been cut over and the best taken for lumber or other purposes. About the Seven Lakes and along Beaver Creek the greater part of the original forest has been destroyed by fire, many of the dead trees still standing, in spite of their destruction more than a quarter of a century ago. These trees, as well as the areas about Glen Cove and those composing the Black Forest, are mostly Engelmann spruce, among which are some range pine (*Pinus aristata*) and white pine (*Pinus flexilis*), which are most plentiful on south slopes, while the higher altitudes with a northerly slope are most exclusively occupied by Engelmann spruce. The tree ordinarily sought here for lumber is the latter species. While occasionally 80 or 90 feet high, with a trunk 2½ feet in diameter, the average available timber trees would not measure above 60 or 70 feet in height and 12 to 15 inches in diameter, and on many portions there is practically no timber left of a size suitable for the sawmill, although much could be utilized for paper pulp.

On account of the extreme variability of the timber on these areas, caused by cutting, by burnings at various times, and by very diverse quality according to exposure or elevation, so that no section or even quarter section of living timber ground can be found giving a fairly uniform growth, it is impossible to give a close estimate of the amount of lumber remaining here without more time for examination and measurements than was available in the present exploration. There are many acres which would cut over 5,000 feet of lumber to the acre if trees less than 10 or 12 inches in diameter were included, but not many acres of such timber could be found together.

With the exception of a few scattered small areas, which are hardly more than groves, there are practically no forests deserving of the name on all the remaining portion of the reserve. In the southern portion, as along North and South Cheyenne creeks, and especially along the line of the wagon road between Colorado Springs and Cripple Creek, there are some patches of light timber; but most of the territory here has been burned over and no important new growth has yet developed, or it bears a very scattered growth of very small or medium-sized trees. Some of the ground on south slopes and in valleys is absolutely bare of trees of any kind.

The species found here are Engelmann spruce, Douglas spruce, yellow pine (*Pinus ponderosa*), some range pine (*P. aristata*), and white pine (*P. flexilis*).

In all the remaining part of the reserve, lying to the north of the Manitou and Pikes Peak Railway, and comprising about 120,000 acres, or two-thirds of its entire area, there is no timber worthy of the name. Between the Pikes Peak Railway and Fountain

Creek, or the line of the Colorado Midland Railway, the principal conspicuous growth is small aspen or "quaking asp," among which are scattered individuals or small groves of conifers, chiefly yellow pine, white pine, and Douglas spruce. Some of these trees are of good size, being the survivors that escaped the earlier great fires, and they bear the seed which is gradually, although very slowly, reforesting this ground, which was mostly burned over between two and three score years ago. The new trees are of various ages, ranging from seedlings to trees above 30 years old. They are usually growing with the aspen, but they are rarely in sufficient numbers together to ultimately produce good timber. This rising generation of trees must arrive at seed-bearing age before, in the course of nature, the ground will become properly and sufficiently stocked.

On the slopes and hills about Fountain Creek, for several miles northwest of Manitou, there is still left a generally open, irregular growth of small-sized or medium-sized yellow pine and Douglas spruce. There is little, however, to furnish ready material for sawmill lumber.

Excepting a comparatively small area, nearly all of the territory lying to the north of Fountain Creek, or more than one-third of the total area of the reserve, may be classed as practically destitute of living timber of any kind except small aspen. This ground, after being cut over, is said to have been burned about the year 1880, only a few small belts, groups, or individuals of the timber then standing escaping the flames. This timber was not large, and the surviving remnants to-day would make mediocre sawmill lumber. They stand like oases in a desert, and the seeds which they produce are the chief hope of natural reforestation of this burned district. Nevertheless, there are yet hundreds of contiguous acres upon which not a single young conifer has yet started to take the place of those destroyed. Near the living trees which escaped burning there is generally a good, although not dense, growth of young trees coming, the individuals becoming more and more isolated and rare with increased distance from the old seed-bearing trees.

The trees killed by the fire are mostly quite sound, and are either standing or fallen to the ground, and are used locally for fuel and other purposes. Over most of this tract the white pine (*Pinus flexilis*) appears to have been plentiful, but yellow pine and Douglas spruce were the prevailing trees, some Engelmann spruce and blue spruce being mixed with them. A narrow strip along the extreme northern end of the reserve, and bordering on the Plum Creek Reserve, escaped the general conflagration of the time, and here are growing small or medium sized trees of the species mentioned, with a considerable percentage of lodgepole pine among them. The best of the timber has been cut out, but what remains is well worth care and protection, and in future should furnish a continual small local supply of building timber.

A. NORTHERN PART OF PIKES PEAK RESERVE BURNT ABOUT 1880

B. ASPEN AND SCATTERED PINUS FLEXILIS ON GROUND IN PIKES PEAK RESERVE

Burnt probably about fifty years ago

FIRES.

No great forest fires have occurred within the Pikes Peak Reserve in recent years. The most serious of the later fires burned over considerable valuable timber lying to the west of Pikes Peak, partly within and partly outside the reserve. This area is said to have been burned in June, 1896, and the owners of sawmills were accounted responsible.

The early fires which devastated a great part of the forest land are said to have taken place when the country was first explored, about half a century ago; and it is claimed that they were started by Indians, who thus attempted to drive out the game before them when they were compelled to leave this region for more distant reserves.

The more recent fires have generally been confined to small areas, and the damage has not been very great in comparison with the earlier fires, which swept the ground and destroyed the primeval growth.

Sparks from locomotives of the Colorado Midland Railway and the Manitou and Pikes Peak Railway have caused numerous small fires, but, in recent years at least, these corporations seem to have taken reasonable precautions to prevent them. Campers, prospectors, and other persons making fires, and careless about guarding or extinguishing them, have sometimes been responsible for considerable damage. Only one fire was recorded during the past season. It occurred in early October among some timber south of Pikes Peak, burned slowly for several days, and was finally extinguished by a snowstorm. The origin of this fire or the extent of the damage could not be ascertained, as there was not time to make a personal inspection of the ground.

Small grass fires are sometimes started from sparks from locomotives, but they are usually quickly suppressed before they get beyond control.

It is probably safe to say that 75 or 80 per cent of the total area shows marks of damage by fire. Some of this burning occurred before the coming of white men, and these tracts have a considerable growth of trees or timber. Most of the forest has been burned since the country was first explored, the great fires about Pikes Peak occurring about fifty years ago, or about 1848, according to the best information obtainable. Aspen and some shrubs are abundant, but conifers are coming in very slowly except in the vicinity of groves or individuals, which escaped the general conflagration.

Dr. W. A. Bell, of Colorado Springs, states that the large burned tract in the northern part of the reserve, north of Fountain Creek, was destroyed by fire about 1880. The few trees and groves which escaped are seeding the ground about them, but it will be centuries before another coniferous forest exists here if natural conditions prevail. The fire burned the humus so thoroughly that the bare disintegrated granite is everywhere apparent. Aspen has come in, and a few shrubs, but grasses and grazing herbs are not abundant, except along some of the small streams.

SETTLEMENTS.

Excepting at Palmer Lake, situated in the northeastern corner there are no large settlements or aggregations of dwellings located within this reserve. There are few ranches or mining camps, and a relatively small proportion of the entire area comes under the provisions of patented or homestead lands.

A large proportion of the lands in private ownership are located near the line of the Colorado Midland Railway, between Manitou and Woodland Park, the latter small settlement being just on the reserve boundary.

Cascade and Green Mountain Falls are the principal stations along this route, the total permanent population being but a few score persons, although in summer it is greatly augmented by tourists and people seeking rest and recreation in the mountains. Ute Park is another small summer resort situated between the two stations mentioned, and there are a number of small ranches distributed along the creek and its tributaries up to Woodland Park, where several dwellings are located within the reserve limits. Although Palmer Lake lies within the reserve, the fact is not generally known among the inhabitants. It is located on the line of the Denver and Rio Grande and of the Atchison, Topeka and Santa Fe railroads, and has a population of between 100 and 150 persons, this number being very greatly increased during the warm season by summer residents, lodgers, and campers.

Glen Cove, on the wagon road on the north side of Pikes Peak, is merely a lodging and way-station house for tourists and is vacated in winter. Along the line of the Manitou and Pikes Peak Railway there are a number of cottages and boarding establishments, occupied in summer, but usually vacant in winter, and near Lake Moraine and above it are the stations and lodgings of those employed in the development of the waterworks.

Along Bear Creek and North Cheyenne Creek are two or three small so-called ranches, and several are on the Cheyenne Mountain wagon road between Colorado Springs and Cripple Creek, the largest and most important being located at Beaver Creek and consisting of four or five occupied buildings, forming a halfway station between the two important towns on the road.

Throughout the reserve there are scattered a few solitary cabins of prospectors or miners, but at present there are no mining camps.

During summer there are many camping parties throughout the reserve, either merely traveling through it or remaining in one location for several weeks together.

A. BEAR CREEK CANYON, PIKES PEAK RESERVE

Timber burnt about fifty years ago, and deadwood largely removed for fuel

B. VIEW ON LINE OF MANITOU AND PIKES PEAK RAILWAY

Aspen burnt about five years ago; new growth of aspen coming

AGRICULTURE AND GRAZING.

There is little practical agriculture possible in this reserve and little is attempted. A few of the hardier grains and vegetables may be raised in limited areas of low altitude where irrigation is possible, as at Palmer Lake, along Fountain Creek, and similar situations.

Along the creeks the ground available and suitable is confined to very narrow strips, rarely more than a few rods wide excepting in a few places where it broadens into so-called parks. It is chiefly devoted to the raising of hay or forage for cattle in winter.

The chief business of the ranches consists in the grazing of cattle, of which there are a considerable number, variously estimated at from two to five thousand head, ranging over most parts of the reserve where pasturage is to be obtained. Fewer cattle range in the northern portion than in the southern part of the reserve. The largest herds belong to a company whose cattle chiefly range in the Beaver Creek region.

A large proportion of the cattle found in the reserve do not belong to persons located upon it, but are branded and driven in from settlements in the surrounding country, being taken out at the approach of winter. On this account it is not easily practicable to get a close estimate of the average number of cattle pastured on the Government land.

The pasturage is undoubtedly greatly inferior to that which formerly existed, and in past years much of the ground has been made to support a larger number of cattle than was warranted by the conditions. There are some areas where grazing should be restricted or abandoned. This is especially true of some of the high slopes or meadow-like intervales at the head of some of the streams to the south of Pikes Peak. Even moderate pasturage here has a tendency toward injuriously affecting the purity of the water supply for domestic purposes upon which the towns below are dependent. Excessive pasturage near the streams has greatly reduced or destroyed the grasses and other herbage and shrubs which should hold the soil and modify the flow of surface waters.

MINING AND LUMBERING.

There are no active, profitable mines located within the reserve limits, but considerable prospecting is carried on in almost all parts by individuals perennially hopeful of finding rich ore. Gold and silver are found, and it seems very probable that important discoveries may yet be made, such as have been made within 2 or 3 miles of the southwestern boundary. It was reported that small mills for the treatment of low-grade ore or gravel were to be erected 2 or 3 miles to the north of Green Mountain Falls, and should these prove successful it is likely that an important industry may be developed in the treatment of a low grade of mineral-bearing rock or gravel, of which there seems to be an abundant supply.

No sawmills are now at work in the reserve. As most of the valuable timber has been either cut or burned, there is little left to induce extensive lumbering operations. On the Cheyenne Mountain road to Cripple Creek a few trees were being cut for telegraph or trolley poles, and in places a few railroad ties were taken. A small portable sawmill was located at Woodland Park, just at the reserve boundaries, and undoubtedly much timber which supplied it was taken from Government land, although, of course, it was claimed that it had been cut on patented land within the reserve limits.

In October, 1898, this mill was moved to another location farther from the reserve boundary. Another sawmill, located at Midland Station, must necessarily draw a large part of its supplies from public lands, perhaps also from the reserve, the boundary of which is within a mile of the mill.

The most extensive recent cutting has taken place within three or four years on the portion of the reserve bearing the heaviest timber, sometimes called the Black Forest, and located to the west of Pikes Peak and Glen Cove.

The numerous sawmill sites or "settings," indicating the moving of the mill from time to time in order to get nearer the trees cut, and the heaps of sawdust and refuse attest the activity and extent of the lumbering carried on here. The locations of the mill and the cuttings were situated in part on reserve land and in part on ground outside of it, but belonging to the Government. The destruction of timber by the ax was finally supplemented by the action of fire, which burned over a large area of that which remained. This fire was believed to be of incendiary origin, in order that the forest might come under the head of dead timber, which is allowed to be taken freely from the reserves. After the cutting and fires had deprived the tract of its best value, Government officials interfered and the sawmill operations were stopped.

In spite of the havoc already accomplished, there is still some good living Engelmann spruce and a small proportion of Douglas spruce here well worth guarding from further damage.

The fires, which occurred in June, 1896, have left a great deal of standing dead, but sound, timber, which is now being utilized for mine timbers. The trees are cut in the forest into various convenient lengths and hauled to the Midland Station of the Midland Terminal Railway, where they are loaded upon flat cars and shipped to Cripple Creek and other mining camps. The logs are shipped without squaring or dressing, or even the removal of bark. Delivered at the cars, logs 16 feet long are paid for at the rate of $2\frac{1}{2}$ to 3 cents per inch of diameter, measured at the small end, and logs from 4 inches in diameter and upward are taken.

At Woodland Park some aspen or quaking asp (*Populus tremuloides*) was collected and shipped to Denver to be manufactured into excelsior. No sticks less than 4 or 5 inches in diameter were shipped. They were usually cut into lengths of 8 or 12 feet, and stripped of bark, and commanded about $4 per cord, delivered at the shipping station. This kind and quality of lumber is very limited in quantity in this region, and the few cords accumulated represented gleanings from both Government and patented ground in the vicinity. A considerable quantity was also collected and shipped at Divide, a station about midway between Woodland Park and Florissant and 2 or 3 miles north of the westernmost part of the reserve. Aspen of fair size grew more plentifully in this vicinity than in most other places seen.

SUGGESTIONS.

As may be readily seen from the foregoing observations and the accompanying photographs, which are selected to show fair average conditions, there is but a small portion of the area of this reserve sufficiently covered with trees to deserve the name of timber land; and from such timber land as exists the best has been already taken out for sawmill lumber and other purposes. Such timber is confined to the southern portion, the northern half being practically timberless. South and west of Pikes Peak a few million feet of lumber could yet be found and taken out without material injury to the present forest covering, but care should be taken in removing old trees, as seedlings or young growths are not abundant. A great many of the trees killed by fire are still sound and in good condition and will be of value both for mining timbers and for fuel, and for the latter purpose will furnish a local supply for many years to come.

On large areas which were completely burned over, and where no conifers escaped destruction, it is probable that, left to natural conditions, two or three centuries must elapse before the ground again bears a scanty covering of medium-sized trees such as formerly grew upon it. Meanwhile aspen and various shrubs will occupy the ground in part. In places where a few trees or groves escaped, or in the neighborhood of unburned areas, the ground is likely to be much sooner filled with a new growth.

The northern part of the reserve may be regarded as of little or no present value as a timber reserve or for agriculture, and on account of the poverty of the soil the grazing is poor and meager. Moderate pasturage here, however, will not seriously affect the returning forest conditions, which will naturally be very slow.

That these conditions could be supplemented and aided artificially and economically by dissemination of seed would seem probable. Certain it is that this territory is fit for little else than the growth of such trees as will exist upon it.

If practicable, it might be well to modify the boundaries of the reserve so that Palmer Lake should not be included within them. It is also important that the actual boundaries should be more clearly marked, and the persons living near them be better informed in regard to them. This is particularly desirable along the boundaries where there is timber, especially in the Black Forest region, in the western part of the reserve, where inquiries were made, and ignorance was professed in regard to the boundaries by persons who were removing dry timber from what was probably Government land.

Without injury to any private rights, at least 15 or 20 square miles lying to the west and southwest of Pikes Peak could be added to the reserve with great advantage. This would include Sentinel Point and other territory above timber line, and the springs or sources of various small streams flowing westward or southward.

The irregular boundary line in the southeastern part of the reserve is inconvenient and without any apparent geographical or topographical significance.

PLUM CREEK TIMBER LAND RESERVE.

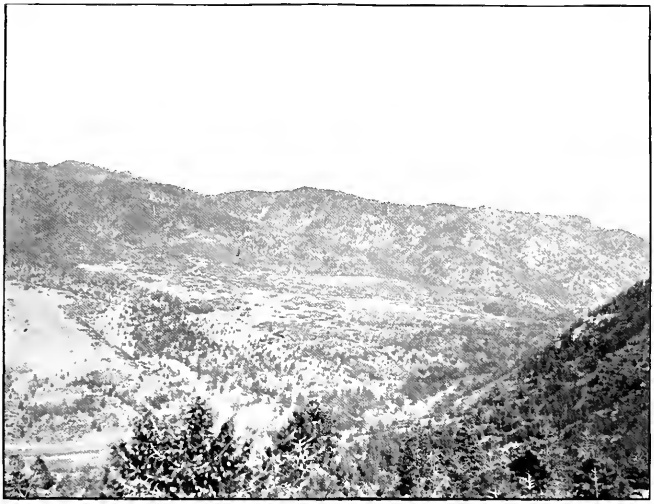
BOUNDARIES.

The boundaries of this reserve, as established by Executive order of June 23, 1892, are as follows:

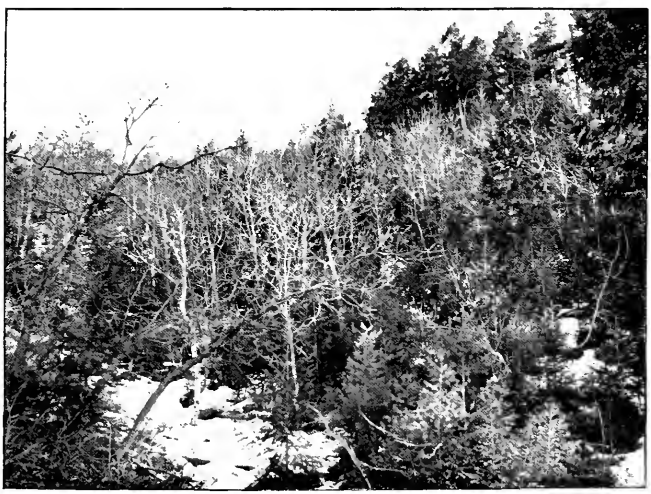
Township ten (10) south, of ranges sixty-eight (68), sixty-nine (69), and seventy (70) west; township nine (9) south, of ranges sixty-eight (68) and sixty-nine (69) west; township eight (8) south, of range sixty-nine (69) west; and so much of township ten (10) south, of range seventy-one (71) west; township nine (9) south, of range seventy (70) west; township eight (8) south, of range seventy (70) west, and township seven (7) south, of range sixty-nine (69) west, as lie to the eastward of the South Platte River.

TOPOGRAPHY AND DRAINAGE.

This reserve is situated directly to the north of the Pikes Peak Reserve, which adjoins it for 6 miles along its southern boundary. It is located entirely within Douglas County, and the area is given as 179,200 acres. The average altitude is much lower than that of any of the three reserves examined, the highest point reaching to less than 9,800 feet, in Thunder Butte, near West Creek, in the southwestern portion; the lowest falling below 5,600 feet in the extreme northeast corner. The reserve as a whole might be likened to a high, hilly plateau, having a diminishing slope northward, and cut by many gulches or canyons having a general easterly or westerly direction. The greater part of the area lies at an altitude between 7,000 and 8,000 feet. Irregular ridges, extending from north to south through the central



A. VIEW LOOKING OVER CASCADE TO NORTH SLOPES OF HILLS ALONG UTE PASS, PIKES PEAK RESERVE



B. EXCEPTIONALLY GOOD STAND OF YOUNG DOUGLAS SPRUCE ON NORTH SLOPE IN PLUM CREEK RESERVE AMONG ASPEN AND SCRUB OAK

Altitude 7,500 feet

part of the reserve throw the waters in an easterly direction into Plum Creek, which falls into the South Platte River below the reserve boundaries, or in a westerly direction into small streams, which also flow into the South Platte along the reserve boundary.

The most important stream flowing through this reserve is West Creek, with its important tributary known as Trout Creek. These really have their sources and some of their most important feeders outside the reserve limits, in the high comparatively level and partly open country lying to the west of the northern part of the Pikes Peak Reserve. They pass through and drain the southwestern portion of the reserve, coming together and forming what is locally called Horse Creek, which runs 4 or 5 miles before entering the South Platte River. The eastern slope of the reserve is drained by several small branches of Plum Creek, the most important of which are West Plum Creek and Jackson Creek, which falls into it.

There are practically no lakes or ponds or important natural reservoirs in the Plum Creek Reserve, but there are several small private storage reservoirs and numerous situations where such could be economically constructed, as they are especially necessary to ranches along the eastern slope.

The amount of water flowing from this reserve is not large, and it is liable to great variation. On account of its relatively low altitude and the absence of dense forest covering, the snows disappear early in the season, so that during summer the smaller creeks sometimes become dry or have a very much diminished flow.

On the west side the extended area of the watershed of West Creek and its tributaries enables this stream to maintain a fair flow of water throughout the year, although much diminished in summer, when many of the smaller tributary creeks and springs become dry.

While passing through the reserve very little of the water is changed from its course for irrigation purposes, although much is used on the lands below.

TIMBER.

The trees of chief economic value in this reserve are yellow pine (*Pinus ponderosa*) and Douglas spruce (*Pseudotsuga taxifolia*), and with these are associated a small amount of blue spruce, Engelmann spruce, *Pinus aristata* and *Pinus flexilis;* while in the southeastern portion, south of Devils Head or Platte Mountain, there is an abundance of lodgepole pine (*Pinus murrayana*). North of Devils Head Mountain a large proportion of the hills or ridges are practically destitute of timber, at best only a few scattered trees being found upon them, although along the intervening gulches or creeks there is or has been a fair growth of small-sized or medium-sized timber trees. These nearly treeless hills generally do not show many indications of ever having borne any heavy forest. They support several species of shrubs, which partly cover the coarse granitic soil.

In the southern portion, which largely has an altitude of from 500 to 1,000 feet greater than the territory to the north of Devils Head Mountain, the country has much more of the appearance of a forest, although the trees are nowhere large or would produce over 2,000 feet of good sawed lumber to the acre on any average measured section of land.

The local demand for lumber and the facility with which it could here be taken out has caused nearly the whole of this reserve to be very thoroughly gone over by lumbermen, and the best has been removed. In some places a second or third culling out of the best trees has taken place. Notwithstanding the activity of sawmills, however, there are still a good many million feet of coarse lumber procurable from yellow pine and Douglas spruce in the southern and southwestern part of the reserve. This fact is well known to the sawmill men, and three or four portable steam sawmills are at work upon what timber remains. Trees 3 feet in diameter of trunk are very rare and most of the logs cut range between 12 and 20 inches in diameter at the stump. With the trees fit for cutting profitably into lumber there is a very large proportion of material of various ages and sizes which will not be serviceable for many years to come and which should receive greater consideration and protection than is usually accorded by wood choppers when taking out the trees which they consider worth cutting.

As in most other parts of this region, it is common to find the slopes facing the south almost bare or producing a very scattered growth of yellow pine, while the opposite northern slopes are much more closely timbered with Douglas spruce and yellow pine, although that which remains is chiefly of small size.

On account of great variation in the conditions and quality of the standing timber, the extensive culling out of the best over all parts, and the numerous practically bare tracts or those which have been burned over, it is extremely difficult to give any close approximate estimate of the quantity of ready available sawmill or railroad-tie timber still standing upon the reserve. From as careful observations and estimates as could be hurriedly made, however, it is probable that, by taking trees above 8 or 10 inches in diameter, at least 50 million or 60 million feet of rough sawmill lumber could still be gleaned from the wooded parts of the reserve.

The clear trunk furnished by the ready sawmill timber is very short, probably not over 25 or 30 feet, but a considerable portion of the limb bearing parts of the trunks are used. Douglas spruce 100 feet high, with 50 feet of clear trunk, and 20 inches in diameter at the stump, is still found in sheltered locations in canyons, but such good

A. LOOKING WEST ABOUT 2 MILES ABOVE FOOT OF HILLS ON JACKSON CREEK ROAD, PLUM CREEK RESERVE

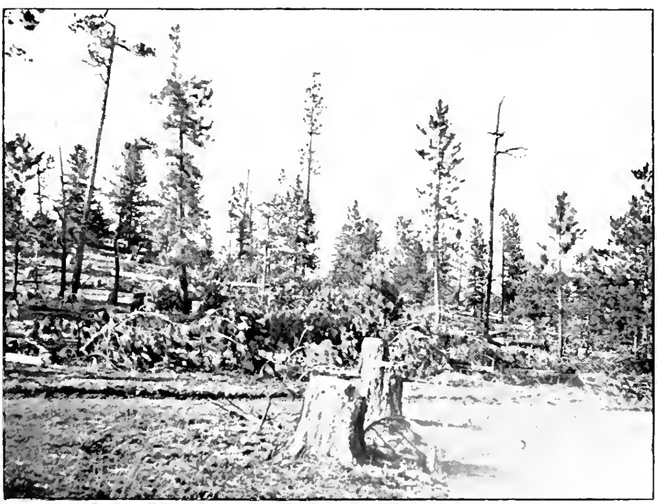
Timber long ago cut off or burnt.

B. AREA EAST OF DEVILS HEAD MOUNTAIN PLUM CREEK RESERVE

Yellow pine and Douglas spruce; few trees large enough for sawmill; much burnt or showing effects of former fires

A SOUTHWEST PART OF PLUM CREEK RESERVE

Exceptionally favorable condition of timber not yet entered by lumbermen. Yellow pine and Douglas spruce



B VIEW ALONG FOURMILE CREEK WEST OF THUNDER BUTTE, PLUM CREEK RESERVE

Remnants of yellow pine and Douglas spruce left by lumbermen.

trees are rare. Some lodgepole pine is fit for use, but most of it is undersized.

In some of the gulches quaking aspen occasionally attains a height of 50 or 60 feet or more with the trunk a foot in diameter, but timber of this species and size is too rare to be of much commercial importance.

FIRES.

Throughout this reserve there are in different parts large areas which have in past years been visited by forest fires, and over much of the territory there are evidences of ground fires which have destroyed the humus, leaving only the bare granite sand. The forest fires have not swept any such extensive continuous areas as in the Pikes Peak Reserve; though they have burned over considerable tracts, they have left intervening groups or belts of living timber, especially in the northern and eastern parts. On some of the burned ground a new growth of conifers is gradually coming in and has already attained good size and density; in others the ground is practically bare, excepting for aspen and various shrubs. Chief among these latter are scrub oak (*Quercus gambelii*), *Ribes cereum*, *Cercocarpus parvifolius*, *Holodiscus discolor*, *Rubus deliciosus*, *Prunus pennsylvanica*, *Ceanothus fendleri*, *Jamesia americana*, and *Arctostaphylos uva-ursi*.

The best timber remaining is in the southern and southwestern part of the reserve and along the South Platte River, and fortunately these parts have not been seriously devastated by fire.

Small burned areas which were set on fire by sparks from sawmill engines are occasionally seen. Several cases of fires started by lightning were reported. No railroad crosses the reserve, but the Colorado and Southern Railway, commonly called the South Park Line, follows the course of the South Platte River along the northern boundary.

North of Devils Head Mountain there are large areas of nearly bare hills which have been swept by fire, although they do not appear to have ever had a dense growth upon them. Upon these hills are a few scattered yellow pines, but little else which can be called arborescent, as the aspen on these dry exposures apparently never grows large. Recovery from the burns must be exceedingly slow, especially on southern slopes. On northern slopes seeds appear to germinate more freely and seedlings more easily get a foothold. South and southwest of Devils Head Mountain the young lodgepole pine is of various sizes, according to the age of the burns, and it sometimes forms almost impenetrable thickets.

The lodgepole pine, on account of its dense growth and resinous character, burns more freely than the other species, and, apparently, small strips are sometimes burned, the fires eventually dying out, so that it is not uncommon to find different areas with trees of two or three distinct ages or periods growing upon a tract of a few hundred acres.

In the more open woodland evidences of surface or ground fires are common, and on these areas there are few or no seedling trees, and older trees sometimes show blackened bark, or destruction of the bark on one side, as evidence of damaging fires which did not reach up among the limbs of the trees, nor were hot enough to destroy the entire bark at the base, and so cause death.

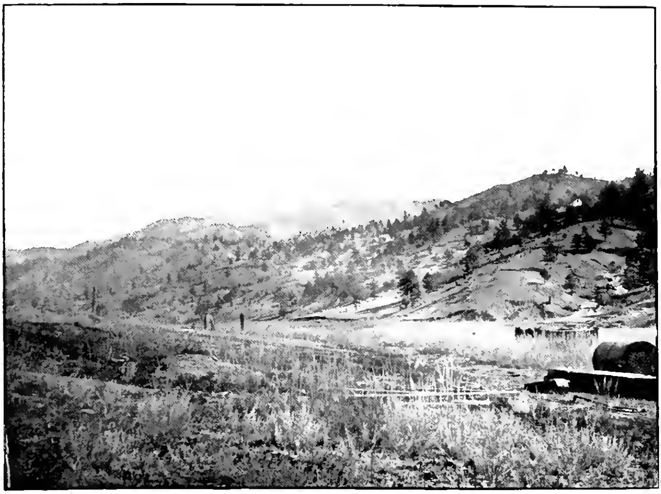
SETTLEMENTS.

A larger proportion of the total area of this reserve is in private ownership, under patent and homestead laws, than in any of the three reserves examined. At least one-third of the territory is claimed under the provisions of these laws. The largest proportion of these lands is situated in those parts having the lowest altitude and most level surface, as at the northern end, and also the middle eastern side, including Perry Park, where there is a solid contiguous block of about 20 square miles of patented land included within the reserve lines. A considerable portion of the patented land is not used or occupied by the owners.

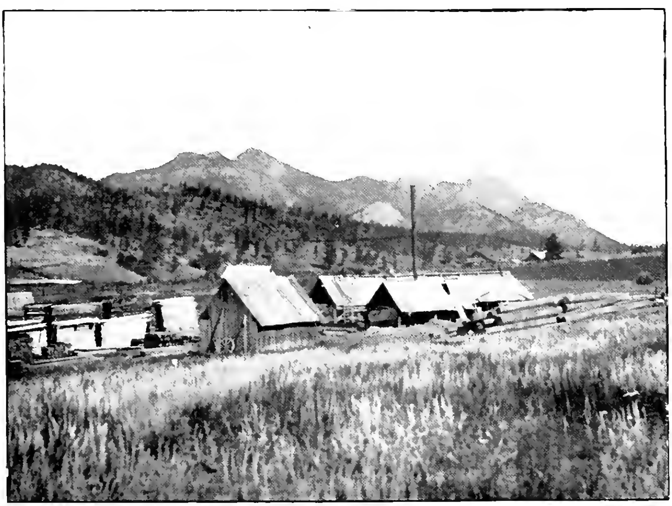
The western side of the Plum Creek Reserve has been the scene of intense mining excitements within the past four or five years, resulting in the establishment of half a dozen small settlements or "town sites." The boom having passed, on account of disappointing expectations as to the richness of the discoveries, the so-called towns are partially deserted for other fields, so that many of the hastily constructed buildings are now without tenants.

The largest of these mining camps is Pemberton, sometimes called West Creek, located on West Creek 9 or 10 miles above its junction with the South Platte River and near the southern boundary of the reserve. Probably two-thirds of the hundred or more habitable buildings were vacant in the summer of 1898, but the population here is liable to considerable fluctuation, from time to time, according to the activity of sawmills in the vicinity or the development of mines or mining prospects.

Other small settlements are Given, about 2 miles above the mouth of West Creek; Daffodil or Trumbull, near the junction of West Creek and the South Platte River; Dunaway and Nighthawk, at intervals of 3 or 4 miles down the South Platte River. These last three places are in part located across the river in the South Platte Reserve, in Jefferson County. They are each composed of merely a few occupied buildings of very cheap construction, and are liable to have their populations depleted or increased any day, according to the rise of mining excitements in other places or developments in the immediate vicinity. At present they derive most of their life from prospectors,



A VIEW AT DUNAWAY, LOOKING NORTHEAST ACROSS SOUTH PLATTE RIVER.



B VIEW ABOVE PEMBERTON (WEST CREEK) PLUM CREEK RESERVE LOOKING NORTHWEST OVER SAWMILL TO THUNDER BUTTE

or from those employed in the lumber business, as much lumber is hauled by team through these places on the way down the valley of the South Platte River to South Platte Station on the South Park Line, whence it is shipped by rail to Denver and other points.

Besides these "town sites," other settlements, mostly abandoned or with but a single occupied dwelling, and prospectors' cabins or ranches are scattered through the reserves, chiefly along the more important creeks. The largest and best ranches are located in the comparatively low region toward the northern end and about Perry Park on the eastern side of the reserve, where there are five or six considerable ranches chiefly devoted to the raising of cattle. Perry Park itself was originally designed as a summer resort by its owners, but at present contains only two or three occupied dwellings, and the hotel is not in use. As the situation is a very picturesque, interesting, and attractive one, it is probable that at some future time a considerable population will be centered here.

At Daffodil, on the South Platte, are so-called mineral springs, which are visited by a varying number of people during the summer, who occupy inexpensive cabins or cottages put up for their accommodation.

The only expensive buildings on the reserve, or those costing more than a few hundred dollars, are located outside of the hills, about Perry Park.

AGRICULTURE AND GRAZING.

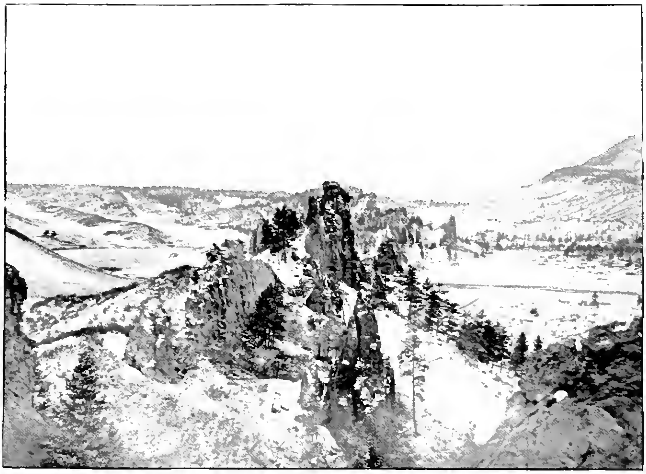
Timber, and possibly mining, must ever remain the chief considerations of commercial value in this reserve. Incidentally, grazing for several thousand cattle may be furnished, but much development of pure agriculture is out of the question. At the lowest altitudes, at the northern end of the reserve and the extreme eastern side, as represented by the vicinity of Perry Park, lying southwest of Dawson Butte, it is possible to raise the hardier cereals and forage crops, potatoes, and other hardy vegetables. Attempts have been made to raise some of the hardier fruits, but as yet with uncertain success. The areas suited to such crops are, however, limited to a comparatively few acres of irrigable land. Oats, rye, potatoes, and other hardy crops are also grown on the narrow strips of fertile or irrigable land bordering the creeks in some places and along the South Platte River. There is a ready local demand for anything that can be raised, and, in fact, most of the food supplies used in the reserve have to be brought in from outside. Grain and fodder are the chief interests cultivated, and are used on the ranches for the cattle and horses in winter.

The so-called ranches vary much in size and value. Some are deserted, some merely prospectors' cabins, others comprise perhaps an acre or two of arable land and three or four head of stock, while the largest may have 300 head of cattle grazing both on patented and reserve Government lands. Two of the largest of these ranches, estimated to graze about 300 head of cattle each, are located in the northern and western slopes of the reserve, and another large one is in the extreme south, near Manitou Park. The size of herds is no indication of proportionate territorial ownership. In summer the cattle on these ranches are usually allowed to roam at large over any part of the reserve and are brought into sheltered places at the approach of severe winter weather.

There may be 50 or 60 persons having ranches upon the reserves, who, in the aggregate, probably have between 1,500 and 2,000 cattle and horses. This, however, does not represent the total number of cattle grazed on the reserve in summer, because a great many are annually sent into the reserve from ranches outside of the boundaries, sometimes at a considerable distance from them. By thus grazing on the public lands the ranchmen are enabled to keep a much greater herd than would be possible on their own comparatively small ranches. On their patented areas they commonly allow the native grass to grow for winter grazing or harvest it, and also raise other forage where irrigation is possible.

As the forested lands are rarely densely covered, some grasses, furnishing scattered and limited grazing, are found almost everywhere; but it is naturally along the creeks that the best and only important pasturage is found. As it is here that cattle find necessary water, and as it is customary to furnish them with salt in such localities in order to keep them together as much as possible, it naturally follows that these regions are most closely grazed. That the grazing is often excessive and too localized is apparent to anyone following many of the streams, particularly the tributaries of Trout Creek and West Creek, in the southwestern part. The consequence is that the pasturage has deteriorated greatly, the ground produces much less food for animals than it did a few years ago, and the conditions are yearly becoming worse. The best forage grasses, having no chance to reproduce themselves by seed, and being constantly cropped almost to the very roots, and crushed or displaced by hoofs, must inevitably become greatly weakened or die out. Moreover, the shrubs and herbaceous vegetation bordering the streams are constantly cropped, trampled upon, and eventually destroyed. These served to protect the banks of the creeks, and prevent them from washing, and also served to check and hold the flow of water in times of unusually heavy precipitation.

The slender streams themselves are trampled and the waters are so polluted as to be unfit for human use, if, indeed, the streams are not practically dry, as they are very apt to be during the late summer season, owing to the unnatural conditions which prevail. Moreover, the excessive number of cattle in some localities is more or less damaging



A. PERRY PARK LOOKING SOUTHEAST FROM HIGH ROCK

Reservoir and C. A. Roberts's house on left

B. DAKAN (PERRY PARK) LOOKING NORTH. DAWSON BUTTE ON RIGHT

Dark patches are chiefly scrub oak

to young forest growth, as even young conifers like Douglas spruce are occasionally browsed upon, and many seedlings are destroyed by trampling.

Unless the grazing is restricted and regulated the pasturage must certainly grow even poorer than it is now. Under proper regulations and limitations a considerable number of cattle might be pastured on the reserve without serious injury, but it would in the end be of greater benefit to the State and Government to prohibit grazing altogether than to allow it to be overdone.

Sheep grazing does not appear to be carried on in or about the reserve.

MINING.

No well-established paying mines are yet in operation, although it is claimed that numerous promising "prospects" have been discovered and only lack capital for their proper development.

Two or three small mills are in course of construction in the Trout Creek Valley north of the southern boundary of the reserve. These are intended to treat by cyanide process low-grade ore-bearing rock or the gravel or sand so abundant in this region and which is said to contain a sufficient percentage of gold to make the workings profitable. Should this prove to be the case, it is likely that it will mean a considerable and permanent addition to the population of this locality. Prospectors are busily engaged in developing shafts or tunnels, constantly having before them the hope that they may make discoveries which will lead to the building up of a second Cripple Creek. That gold exists here there is ample evidence, and it is chiefly a question of the abundance of mineral-bearing rock and of the employment of capital necessary to get it out economically. Persons having ranches or cattle in the reserve, or in other kinds of business, besides professional miners and prospectors, give some time to prospecting when not otherwise employed.

While the principal mining or prospecting has been developed in the West Creek and Trout Creek regions and along the South Platte River, there are men in other parts of the reserve who are prosecuting the search for the precious metals. On the eastern side of the reserve, in Spring Creek Canyon near Perry Park, a tunnel 170 feet in length was found, from which it was stated that pay ore had been taken which assayed about $35 in gold and 300 ounces in silver to the ton. The statements of prospectors are not always to be implicitly relied upon, however, as they are likely to be biased by their hopes.

In the Perry Park territory, on the eastern edge of the reserve, a small mill has been started for the manufacture of plaster and similar products from gypsum and other rock suitable for such purposes, which is plentiful in this locality. The product is shipped by railroad to Denver, Colorado Springs, or wherever a market can be found. The work is yet largely experimental, but may develop into a considerable business.

LUMBERING.

A good deal of lumbering is still carried on in this reserve, no doubt largely illegally, although usually claimed to be under the provisions of existing laws. At the time the reserve was examined six portable steam sawmills were in operation upon it, altogether capable of turning out between 60,000 and 70,000 feet of lumber a day when running full time. The largest of these mills was located on Fourmile Creek, west of Thunder Butte, and was stated to be able to produce from 15,000 to 18,000 feet a day. This mill had exhausted the adjacent supplies and was preparing for removal to another location within a few miles. It was claimed that the mill was located on private holdings of land and that the cuttings were from a purchased school section.

Another mill is situated about a mile south of Pemberton. Its reported capacity was 12,000 or 13,000 feet of lumber a day, and it had been located on the same site for over a year and a half, a longer time than the average period for an active mill to remain in the same place.

A large mill with a capacity of about 15,000 feet of lumber a day had been at work near the mouth of West Creek but was in process of removal to a location outside of the reserve, where a more abundant timber supply was obtainable.

A mill capable of cutting 8,000 or 10,000 feet a day had been recently relocated at the head of Jackson Creek, to the west of Devils Head Mountain, cutting from what was claimed to be homestead and school-section land. It had previously been located farther down Jackson Creek. About 3 miles east of Nighthawk, on the road to Sedalia, a small sawmill was at work, and another was located on the eastern slope south of Perry Park.

Along rivers and creeks throughout the reserve, piles of sawdust and sawmill refuse are frequently met, each one indicating the base of active operations of some lumberman for a time. These piles are commonly left to sink gradually into decay, but at Given the great accumulation of sawdust left by a recently removed mill was burning and probably continued to burn for several weeks.

The lumber cut and sold by these mills is practically all yellow pine and Douglas spruce, the pine constituting decidedly the larger proportion. It is used locally for buildings, mines, and other uses, and commonly sells for $8 or $9 per 1,000 feet at the sawmill. The lumber sold for use in the reserve, however, constitutes but a very small fraction of the total amount cut, most of it being shipped to markets far outside the reservation limits. This involves long hauls by team

A PERRY PARK LOOKING SOUTH-SOUTHEAST FROM HIGH ROCK

B PERRY PARK LOOKING EAST FROM HIGH ROCK

to distant railroad stations. The chief shipping point for lumber from this reserve is South Platte, on the South Park Line. Florissant, on the Colorado Midland Railway, also receives some of it, and lumber from the Jackson Creek region is hauled to Sedalia for sale and shipment.

At South Platte it was estimated that from 25,000 to 50,000 feet of lumber was loaded on cars and shipped daily, the points to which it was consigned being Denver and other commercial or demand centers. The lumber here is usually hauled by teams of four horses drawing two wagons together, and carrying 3,000 or 4,000 feet of lumber. Delivered at the railroad station it is worth $11 or $12 per 1,000 feet, pine and spruce generally being sold together and not sorted. Sometimes Douglas spruce is kept separate and cut into planks for bridges.

The lumber roads are in fair condition, especially along the South Platte River, where the present wagon road was once graded for a railroad, but upon which the rails were never laid.

Nearly all parts of the reserve are comparatively easy of access, and roads are sought or cut as the encroachments and demands of the sawmill necessitate in order to obtain fresh supplies of logs. Some of the ground has been cut over a second time, and even a third time, the first cuttings having taken only the larger trees, the last taking whatever can be found of sufficient size to yield a cash profit. Sticks not more than 8 inches in diameter are sometimes used by the smaller mills.

Whenever possible it is the custom to locate the sawmill on patented or homestead land, the timber thereon, and perhaps also the timber upon a school section, being purchased. But the tree cutter knows no boundaries, and the best timber is taken wherever found so long as there is no interference by Federal authorities.

The excuse is made by lumbermen and inhabitants that the cutting and shipping of lumber is necessary to give employment to people settled in the reserve, who may be prospecting part of their time, and who practically depend upon what they may earn at lumbering for subsistence. But at the present rate of cutting the ready lumber will soon be exhausted, although such considerations give little trouble to the men who think only of themselves and their immediate welfare—a class too common in the region of mining camps.

Should important mining industries ever be developed here all the timber in the region around would be needed for local use, but if it is allowed to be shipped to other parts of the State at the present rate the time may come when lumber will be brought in from outside, at a much higher cost to the miner.

Among other schemes for illegally getting timber from Government land, both in and outside the reserve, is the practice of staking out a mining claim on some heavily timbered spot, cutting and selling the timber, and then abandoning the claim without attempting to get final deed or patent for it. As a mining claim includes about 10 acres, it is apparent that by frequent repetition of this scheme upon the very localized areas of good timber much of the best would very speedily be removed.

Besides the sawmills found at work within the reserve, several are or were located on unreserved Government land to the south, procuring their timber largely from ground upon which they had secured no right to trespass. There were rumors of the coming of other mills to this section, in which much good timber is still to be found, better in fact than now exists within the boundaries of the reserve. It is altogether probable that other mills will locate within the reserve unless prevented by legal action. As it is generally considered more economical to move the mill from place to place as the local supply of timber is exhausted, instead of hauling the logs to the mill from any considerable distance, most of the active mills occupy a given site for only a few months.

Great quantities of railroad ties have in the past been cut in the reserve and sold to the various railroads having stations within hauling distance. The cutting of ties is still carried on, although only locally and in comparatively small numbers. The work has been done under certain rights and privileges claimed by the railroads, by cutting upon homestead and patented lands, upon mining claims, or the timber has been boldly taken from Government land wherever trees of suitable size were found. Most of the cutting, however, has been done under cover of concessions claimed to have been granted to the railroads, but about the legality of which there appeared locally to be doubt and dispute. Douglas (locally called red) spruce is the species almost exclusively used. Standard ties are cut 8 feet long and dressed or hewn on two opposite sides to 7 inches in diameter, the other two sides being allowed the full diameter of the tree stripped of bark. All sticks must be large enough to square 7 inches when dressed, but no limit is placed upon the maximum size or diameter of the tie in the broadest or undressed direction. This usually regulates itself, as very large trees involve too much hewing and are too heavy and bulky for hauling most economically, inasmuch as the railroads pay no more for extra large ties than for those coming just within acceptable minimum dimensions. Such standard railroad ties are worth 35 cents each, delivered at a railroad station.

From some of the best of the Douglas spruce to be found, which are trees about 20 inches in diameter at the stump and 100 feet in height, 8 good ties may be cut, making a total length of 64 feet. Such trees are rare, and are found in only a few favored canyons; and, as a rule, not more than three or four ties are procured from each tree.

The cutting is done by outsiders, who come in for the sole purpose of getting out ties, or by persons owning ranches or land in the reserve, or by prospectors who, in many cases, having spent all their capital in sinking shafts or tunneling, cut ties as almost their only means of obtaining subsistence to prosecute their mining work in their particular locality. The cutting of ties is often very wasteful of good Douglas spruce, which could be made to yield fine sawmill timber.

Dry yellow pine or Douglas spruce which has died or been killed by fire is sometimes collected, hauled to railroad stations, and shipped for fuel. Such wood delivered at South Platte Station was paid for at the rate of about $2.75 per cord. It involved a haul of 6 or 8 miles.

SUGGESTIONS.

This reserve must be considered as essentially a timber reserve, rather than one likely to furnish very important water supplies. The timber should be much more rigidly protected from inroads by thieves and damage by fire. On thinly-wooded areas no trees should be allowed to be cut, even although mature, because they are essential as seed producers and give shelter and shade to the ground while the seed is germinating and young trees are getting established.

Such treatment would apply to nearly all the territory to the north of a line drawn east and west of Devils Head Mountain and much other to the south. South of Devils Head Mountain is located nearly all the timber which has an immediate marketable value and which could be cut without great damage to the forest covering. Much of this, however, is second-rate or third-rate in size and could advantageously be allowed to remain for many years. When cut, it should be under the general supervision of someone who would see that the young growth remaining was not needlessly injured.

All the lumber grown on the reserve may yet be necessary for consumption within or near it, and, as a means of conservation, a rule prohibiting the shipping of lumber to distant points might be beneficial. The exclusion of sawmills altogether from the reserve for a term of years would certainly be no injury to the forest crop and would eventually be a gain to bona fide residents. At present the lumber is chiefly taken by outside lumber companies which, after taking out what they are allowed to or can conveniently find, move out to other places, leaving the country deprived of its best crop, for which little or no return has been given. One or two licensed sawmills conscientiously managed could be worked with profit and would yield some return to the Government, but the wholesale indiscriminate destruction, carried on as in the past, should be stopped.

Pasturage, too, should be regulated and restricted, and it is believed that a tax, however small or nominal, on all cattle allowed to range on Government land or found thereon, would have a beneficial effect. As all cattle are branded, the collection of such a tax or the registering of licenses should be practicable.

The boundaries of the reserve include some nearly treeless and purely agricultural or grazing lands along the eastern side, which are almost entirely held in private ownership. For this reason it may be considered best to eliminate a strip which includes Perry Park, and is 6 or 7 miles in length by about 3 in width. This portion of the reserve is traversed by about 5 miles of the direct public road between Palmer Lake, Sedalia, and Denver. Perry Park itself is a very interesting and attractive locality, chiefly on account of the peculiar tilted sandstone rocks and cliffs which are the distinguishing features of its surface and which in some respects are not excelled by the similar formations of the Garden of the Gods, near Manitou.

The laws regarding the cutting of railroad ties and sale of them to railroads, also the rights of railroads to timber from the reserves, should be better known among the people. The laws regarding lumbering are also imperfectly understood.

If copies of rules and regulations and some plan of description of the reserve boundaries could be served upon property owners in the reserve, and posted in public places in the country about it, there would be less excuse for trespass than now exists.

Where there are no guideposts or natural features to indicate boundaries notices posted along roads or trails crossing them should also serve for the same purpose.

The considerable area of land in private ownership is likely to be a constant source of trouble in maintaining the integrity of the reserve for timber production.

Of the three reserves examined the Plum Creek Reserve is the least important for the general welfare of the community, and at least the northern half could be eliminated without appreciably affecting the present or future water or timber supplies.

THE SOUTH PLATTE FOREST RESERVE.

BOUNDARIES.

The boundaries of the reserve as established by Executive order of December 9, 1892, are as follows:

Beginning at the confluence of the North Fork of the South Platte River with the South Platte River; thence up the middle of the channel of the North Fork of the South Platte River to the range line between township seven (7) south, ranges seventy-four (74) and seventy-five (75) west of the sixth (6th) principal meridian; thence northerly on said range line to the northeast corner of township seven (7) south, range seventy-five (75) west; thence westerly on the township line between townships six (6) and seven (7) south to the northwest corner of township seven (7) south, range seventy-six (76) west; thence southerly on the range line between ranges seventy-six (76) and seventy-seven (77) west to the northeast corner of section thirteen (13), township seven (7) south, range seventy-seven (77) west; thence westerly on the section line between sections twelve (12) and thirteen (13) to the northwest corner of section thirteen (13) of said township and range; thence southerly on the section line between sections thirteen (13) and fourteen (14), twenty-three (23) and twenty-four (24), and twenty-five (25) and twenty-six (26) to the northeast corner of section thirty-five (35) of said township and range; thence westerly on the section line between sections twenty-six (26) and thirty-five (35), and twenty-seven (27) and thirty-four (34) to the northwest corner of section thirty-four (34) of said township and range; thence southerly on the section line between sections thirty-three (33) and thirty-four (34) of said township and range, and sections three (3) and four (4), nine (9) and ten (10) and fifteen (15) and sixteen (16), township eight (8) south, range seventy-seven (77) west to the northeast corner of section twenty-one (21) of said last-named township and range; thence westerly on the section line between sections sixteen (16) and twenty-one (21), seventeen (17) and twenty (20), and eighteen (18) and nineteen (19) to the northwest corner of section nineteen (19) of said township and range; thence southerly on the range line between ranges seventy-seven (77) and seventy-eight (78) west to the northeast corner of section thirteen (13), township nine (9) south, range seventy-eight (78) west; thence westerly on the section line between sections twelve (12) and thirteen (13) and eleven (11) and fourteen (14) to the northwest corner of section fourteen (14) of said township and range; thence southerly on the section line between sections fourteen (14) and fifteen (15) to the southwest corner of said section fourteen (14); thence westerly on the section line between sections fifteen (15) and twenty-two (22) and sixteen (16) and twenty-one (21) to the northwest corner of section twenty-one (21) of said township and range; thence southerly on the section line between sections twenty (20) and twenty-one (21) and twenty-eight (28) and twenty-nine (29), to the southwest corner of section twenty-eight (28) of said township and range; thence easterly on the section line between sections twenty-eight (28) and thirty-three (33), to the southeast corner of said section twenty-eight (28); thence southerly on the section line between sections thirty-three (33) and thirty-four (34) of said township and range, and sections three (3) and four (4), nine (9) and ten (10), and fifteen (15) and sixteen (16), township ten (10) south, range seventy-eight (78) west, to the northeast corner of section twenty-one (21) of said last-named township and range; thence westerly on the section line between sections sixteen (16) and twenty-one (21), seventeen (17) and twenty (20), and eighteen (18) and nineteen (19), to the northwest corner of section nineteen (19) of said township and range; thence southerly on the range line between ranges seventy-eight (78) and seventy-nine (79) west, to the southwest corner of township ten (10) south, range seventy-eight (78) west; thence westerly on the second (2nd) correction line south to the northwest corner of section one (1), township eleven (11) south, range seventy-nine (79) west; thence southerly on the section line between sections one (1) and two (2), eleven (11) and twelve (12), thirteen (13) and fourteen (14), twenty-three (23) and twenty-four (24), twenty-five (25) and twenty-six (26), and thirty-five (35) and thirty-six (36) of said township and range, and sections one (1) and two (2), eleven (11) and twelve (12), and thirteen (13) and fourteen (14), township twelve (12) south, range seventy-nine (79) west, to the southwest corner of section thirteen (13) of said last-named township and range; thence easterly on the section line between sections thirteen (13) and twenty-four (24) of said township and range, and sections eighteen (18) and nineteen (19), seventeen (17) and twenty (20), sixteen (16) and twenty-one (21), and fifteen (15) and twenty-two (22), township twelve (12) south, range seventy-eight (78) west, to the quarter section corner between said sections fifteen (15) and twenty-two (22); thence southerly through the middle of sections twenty-two (22), twenty-seven (27), and thirty-four (34) to the quarter section corner on the south boundary of section thirty-four (34) of said township and range; thence easterly on the township line between townships twelve (12) and thirteen (13) south, range seventy-eight (78) west, to the northwest corner of township thirteen (13) south, range seventy-seven (77) west; thence southerly on the range line between ranges seventy-seven (77) and seventy-eight (78) west to the southwest corner of section six (6), township thirteen (13) south, range seventy-seven (77) west; thence easterly on the section line between sections six (6) and seven (7), five (5) and eight (8), and four (4) and nine (9) to the southeast corner of section four (4) of said township and range; thence northerly on the section line between sections three (3) and four (4) of said township and range and sections thirty-three (33) and thirty-four (34), township twelve (12) south, range seventy-seven (77) west, to the northeast corner of section thirty-three (33) of said last-named township and range; thence easterly on the section line between sections twenty-seven (27) and thirty-four (34), to the southeast corner of section twenty-seven (27) of said township and range; thence northerly on the section line between sections twenty-six (26) and twenty-seven (27), twenty-two (22) and twenty-three (23), fourteen (14) and fifteen (15), ten (10) and eleven (11), and two (2) and three (3) of said township and range, and sections thirty-four (34) and thirty-five (35), township eleven (11) south, range seventy-seven (77) west, to the northeast corner of section thirty-four (34) of said township and range; thence westerly on the section line between sections twenty-seven (27) and thirty-four (34), to the northwest corner of said section thirty-four (34); thence northerly on the section line between sections twenty-seven (27) and twenty-eight (28), to the northeast corner of section twenty-eight (28) of said township and range; thence westerly on the section line between sections twenty-one (21) and twenty-eight (28), twenty (20) and twenty-nine (29), and nineteen (19) and thirty (30), to the northwest corner of section thirty (30) of said township and range; thence northerly on the range line between ranges seventy-seven (77) and seventy-eight (78) west, to the northeast corner of township eleven (11) south, range seventy-eight (78) west; thence easterly on the second (2d) correction line south, to the southeast corner of township ten (10) south, range seventy-eight (78) west; thence northerly on the range line between ranges seventy-seven (77) and seventy-eight (78) west, to the southwest corner of section eighteen (18), township nine (9) south, range seventy-seven (77) west; thence easterly on the section line between sections eighteen (18) and nineteen (19), seventeen (17) and twenty (20), sixteen (16) and twenty-one (21), and fifteen (15) and twenty-two (22), to the southeast corner of section fifteen (15) of said township and range; thence northerly on the section line between sections fourteen (14) and fifteen (15), and ten (10) and eleven (11), to the southwest corner of section two (2) of said township and range; thence easterly on the section line between sections two (2) and eleven (11), and one (1) and twelve (12), to the southeast corner of section one (1) of said township and range; thence northerly on the range line between ranges seventy-six (76) and seventy-seven (77) west, to the southwest corner of township eight (8) south, range seventy-six (76) west; thence easterly on the township line between townships eight (8) and nine (9) south, range seventy-six (76) west, to the southeast corner of section thirty-one (31), township eight (8) south, range seventy-six (76) west; thence northerly on the section line between sections thirty-one (31) and thirty-two (32), to the southwest corner of section twenty-nine (29) of said township and range; thence easterly on the section line between sections twenty-nine (29) and thirty-two (32), to the southeast corner of said section twenty-nine (29); thence northerly on the section line between sections twenty-eight (28) and twenty-nine (29) and twenty (20) and twenty-one (21), to the southwest corner of section sixteen (16) of said township and range; thence easterly on the section line between sections sixteen (16) and twenty-one (21), to the southeast corner of said section sixteen (16); thence northerly on the section line between sections fifteen (15) and sixteen (16), nine (9) and ten (10), and three (3) and four (4) of said township and range, and sections thirty-three (33) and thirty-four (34), township seven (7) south, range seventy-six (76) west, to the southwest corner of section twenty-seven (27) of said township and range; thence easterly on the section line between sections twenty-seven (27) and thirty-four (34), twenty-six (26) and thirty-five (35), and twenty-five (25) and thirty-six (36) of said township and range, and sections thirty (30) and thirty-one (31), twenty-nine (29) and thirty-two (32), twenty-eight (28) and thirty-three (33), and twenty-seven (27) and thirty-four (34), township seven (7) south, range seventy-five (75) west, to the northwest corner of section thirty-five (35) of said township and range; thence southerly on the section line between sections thirty-four and thirty-five (35) of said township and range, and sections two (2) and three (3), ten (10) and eleven (11), fourteen (14) and fifteen (15), twenty-two (22) and twenty-three (23), twenty-six (26) and twenty-seven (27), and thirty-four (34) and thirty-five (35), township eight (8) south, range seventy-five (75) west, to the southwest corner of section thirty-five (35) of said township and range; thence easterly on the township line between townships eight (8) and nine (9) south, range seventy-five (75) west, to the northwest corner of township nine (9) south, range seventy-four (74) west; thence southerly on the range line between ranges seventy-four (74) and seventy-five (75) west to the southwest corner of township ten (10) south, range seventy-four (74) west; thence easterly on the second (2nd) correction line south to the northwest corner of township eleven (11) south, range seventy-three (73) west; thence southerly on the range line between ranges seventy-three (73) and seventy-four (74) west to the northeast corner of section thirteen (13), township twelve (12) south, range seventy-four (74) west; thence westerly on the section line between sections twelve (12) and thirteen (13), and eleven (11) and fourteen (14) of said township and range, to the quarter-section corner between said sections eleven (11) and fourteen (14); thence southerly through the middle of sections fourteen (14), twenty-three (23), and twenty-six (26) to the center of section twenty-six (26) of said township and range; thence easterly through the middle of sections twenty-six (26) and twenty-five (25) to the quarter section corner on the range line between section twenty-five (25), township twelve (12) south, range seventy-four (74) west, and section thirty (30), township twelve (12) south, range seventy-three (73) west; thence southerly on said range line to the southwest corner of township twelve (12) south, range seventy-three (73) west; thence easterly on the township line between townships twelve (12) and thirteen (13) south, to the southeast corner of township twelve (12) south, range seventy-three (73) west; thence southerly on the range line between ranges seventy-two (72) and seventy-three (73) west, to the northeast corner of section twenty-four (24), township thirteen (13) south, range seventy-three (73) west; thence westerly on the section line between sections thirteen (13) and twenty-four (24), fourteen (14) and twenty-three (23), fifteen (15) and twenty-two (22), sixteen (16) and twenty-one (21), seventeen (17) and twenty (20), and eighteen (18) and nineteen (19), to the northwest corner of section nineteen (19) of said township and range; thence southerly on the range line between ranges seventy-three (73) and seventy-four (74) west, to the quarter section corner on the west boundary of section eighteen (18), township fourteen (14) south, range seventy-three (73) west; thence easterly through the middle of sections eighteen (18), seventeen (17), sixteen (16), fifteen (15), fourteen (14), and thirteen (13), township fourteen (14) south, range seventy-three (73) west, and sections eighteen (18) and seventeen (17), township fourteen (14) south, range seventy-two (72) west, to the quarter section corner between sections seventeen (17) and sixteen (16) of said last-named township and range; thence northerly on the section line between sections sixteen (16) and seventeen (17), and eight (8) and nine (9), to the northeast corner of section eight (8) of said township and range; thence easterly on the section line between sections four (4) and nine (9), three (3) and ten (10), two (2) and eleven (11), and one (1) and twelve (12), to the southeast corner of section one (1) of said township and range; thence northerly on the range line between ranges seventy-one (71) and seventy-two (72) west, to the southwest corner of township thirteen (13) south, range seventy-one (71) west; thence easterly on the township line between townships thirteen (13) and fourteen (14) south, to the southeast corner of section thirty-three (33), township thirteen (13) south, range seventy-one (71) west; thence northerly on the section line between sections thirty-three (33) and thirty-four (34), twenty-seven (27) and twenty-eight (28), twenty-one (21) and twenty-two (22), fifteen (15) and sixteen (16), nine (9) and ten (10), and three (3) and four (4) of said township and range, and between sections thirty-three (33) and thirty-four (34), twenty-seven (27) and twenty-eight (28), twenty-one (21) and twenty-two (22), fifteen (15) and sixteen (16), nine (9) and ten (10), and three (3) and four (4), township twelve (12) south, range seventy-one (71) west, and between sections thirty-three (33) and thirty-four (34), twenty-seven (27) and twenty-eight (28), twenty-one (21) and twenty-two (22), fifteen (15) and sixteen (16), nine (9) and ten (10), and three (3) and (4), township eleven (11) south, range seventy-one (71) west, to the northeast corner of section four (4) of said last-named township and range; thence easterly on the second (2nd) correction line south, to the southeast corner of section thirty-three (33), township ten (10) south, range seventy-one (71) west; thence northerly on the section line between sections thirty-three (33) and thirty-four (34) of said township and range, to the middle of the channel of the South Platte River; thence down the middle of the channel of the said river to its confluence with the North Fork of the South Platte River, the place of beginning.

TOPOGRAPHY AND DRAINAGE.

The South Platte Reserve includes 683,520 acres, an area nearly twice that of the combined extent of the Pikes Peak and Plum Creek reserves. The main body of it lies directly west of the Plum Creek Reserve and South Platte River, a small portion extending south of the latter stream. A long, narrow strip or arm extends from the northwest corner of the main part of the reserve along the eastern base of the Park Range of mountains, forming a western boundary to the district known as South Park.

Most of this reserve lies at a much greater average altitude than the Plum Creek Reserve, and the extremes of altitude are much greater. The lowest point is in the northeast corner, at the junction of the North Branch of the South Platte with the South Platte River, where the altitude is a little above 6,000 feet for some distance along the shores of these streams. From this point the area within the reserve rises abruptly and rapidly in irregular ridges, hills, and mountains, divided by innumerable ravines, gulches, or canyons. In the main body of the reserve, which lies between South Platte River and the unreserved area known as South Park, there are a number of mountains and ranges which rise well above timber line, reaching an altitude of 12,400 or 12,500 feet. These nearly surround the regions known as Lost Park and Craig Park or Mountain Meadows, which have a minimum elevation of about 9,000 feet and form most important feeders to the streams which flow out of them.

South of Tarryall Creek the average altitude is much less than to the north, and there are no mountains reaching the timber-line limit. The larger portion of the important territory of the reserve lies between 8,000 and 10,000 feet altitude.

West of the main body of the South Platte Reserve is the agricultural or grazing country known as South Park, the free limits of which are not generally locally known and which, topographically, can not be distinguished from considerable areas included within the reserve. It is in part composed of a nearly level, treeless plain, having an altitude mostly between 8,500 and 9,500 feet or higher, and in part of irregular, thinly-timbered hills or ridges with open treeless areas or "parks" between them. It serves for the pasturage of many thousands of cattle and sheep, the grass being good and much hay being raised where irrigation from the Platte River and Tarryall Creek is possible, these streams crossing it in a southeasterly direction.

North and west of South Park lies the western branch or arm of the South Platte Reserve, a narrow strip over 40 miles long and varying in width from 1½ to 11 miles, with an average width of perhaps 4 or 5 miles. It is mainly composed of high, broad hills or mountains, and practically forms the lower eastern slope of what is known as the Park Range. Some of these mountains included in the reserve rise above timber line, but most of them bear trees to the summits.

The highest peaks and the highest parts of the Park Range of mountains lie to the west, outside the limits of the reserve, and conspicuously above timber line. In the ravines and gulches near the summits of some of these there are huge drifts of snow which do not disappear during the summer, and it is fróm these perpetual snow banks that many of the streams start which cross the narrow western arm of the reservation, and which form the South Platte River and Tarryall Creek, these streams draining the entire eastern slope of the Park Range, and also the South Park.

The main body or eastern portion of South Platte Reserve is chiefly drained by the South Platte River itself and the very numerous streams which fall into it, the most important of which is Tarryall Creek, while the tributary known as Goose Creek or Lost Park Creek carries the waters from an extensive area most valuable as a water reservoir. This area is also partly drained by Craig Creek, the waters of which, and also of Buffalo Creek, flow into the north branch of the South Platte River, which drains a small watershed sloping to the north.

While South Platte River and Tarryall Creek drain most of the reserve, their true sources are many miles to the west, in the higher Park Range, just outside the limits of its western arm of the reserve. The South Platte is a comparatively small stream, rarely more than a few rods in width, and easily forded at many points, but it is very important to the region through which it flows.

The largest and practically the only large natural body of water in the reserve is known as Jefferson Lake, located at an altitude between 10,500 and 11,000 feet, at the head of Jefferson Creek, one of the branches of Tarryall Creek. This lake is more than half a mile across in its widest part, and soundings are said to have shown a depth of 850 feet. A few feet of its waters are now artificially drawn off to supply the necessities of a number of ranchmen along Jefferson Creek, in South Park, below. It is a very valuable natural reservoir, chiefly fed from perpetual snow banks, lying west of and outside the reserve lines.

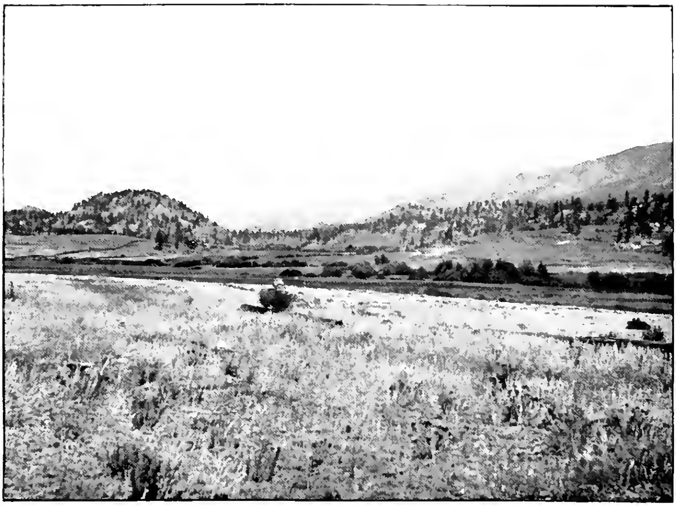
Lake George is merely an artificial reservoir formed by damming the South Platte River, and Wellington Lake was made by building a dam near the head of Buffalo Creek. The altitude of each of these reservoirs is about 8,000 feet.

There are various reservoirs projected or in course of construction in this reserve, the most important being on the South Platte River, on Goose Creek (also known as Lost Park Creek), and on Tarryall Creek. Near the outlet of the latter active preparations were being made during the summer of 1898 for the construction of a reservoir which would have a maximum depth of over 100 feet of water and cover over 2,000 acres. The conservation of these waters is primarily intended for the supply of the city of Denver, about 50 miles away.

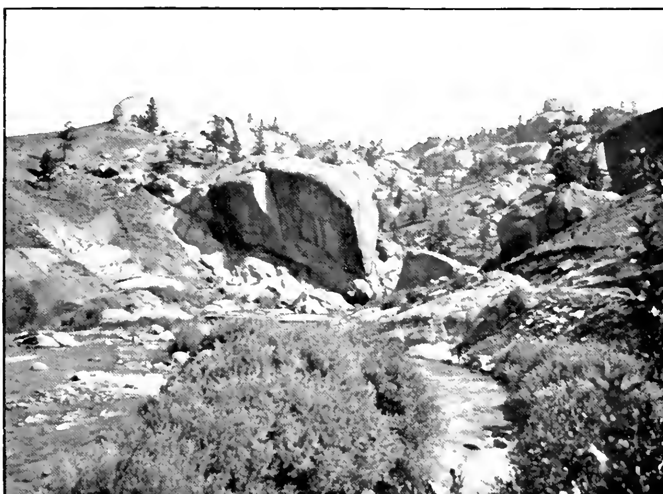
Throughout the reserve, especially in the higher altitudes, there are innumerable springs, most of which maintain a good flow of the finest water in the driest seasons. In the Lost Park and Craig Park district there are large areas of treeless, boggy, or peaty ground which are practically reservoirs holding and gradually giving out large and perpetual supplies of pure and very cold water to the streams which run through them. These boggy areas are commonly covered with low shrubby willows from 2 to 8 feet high, and mixed with them are various grasses, sedges, and mosses which, with the accumulated humus of centuries, hold and but slowly release the water which stands beneath or among them. These areas might properly be likened to slowly-flowing reservoirs or lakes which are concealed by the subalpine vegetation growing over them. As a feeder of streams, this region, giving its waters to Lost Park Creek and Craig Creek, is the most valuable of any found within any of the three reserves examined, and no effort should be spared to preserve or improve the present conditions existing there.

On account of its limited area and topographical position, much of the extreme western section of the reserve contributes comparatively little water to the streams, most of it coming from farther to the west, from the eastern slope of the high Park Range, several of the summits of which exceed Pikes Peak in altitude.

A number of small natural ponds or artificial storage reservoirs



A SITE OF PROPOSED RESERVOIR ON SOUTH PLATTE RIVER, ABOVE MOUTH OF TARRYALL CREEK



B SITE OF PROPOSED DAM ON SOUTH PLATTE RIVER 2 OR 3 MILES ABOVE SOUTH PLATTE STATION

occur at various points along this range. The broader southern end of this part of the reserve is the most valuable as a stream-feeder, as it includes the apex of the watershed and the beginnings of the creeks.

TIMBER.

The South Platte Reserve contains a varied assortment of forest conditions, and, like most parts of the country accessible to markets or railroads, the surface has been very largely deprived of its most valuable timber by the rapacity of sawmill men and of railroad-tie hunters; many thousands of acres also having been cleared by manufacturers of charcoal for smelting purposes.

What remains of unmolested primeval forest is chiefly located farthest away from local markets or shipping stations, or is situated in limited areas on slopes not easily accessible. The timber in which the operations of lumbermen have not yet been very destructive comprises but a few thousand acres, mostly located north of the Tarryall Mountains, about the head waters of Lost Park Creek, Wigwam Creek, and Craig Creek, in and about the vaguely defined region generally known as Lost Park, having an altitude of from above 9,000 to 11,500 feet or more.

The valuable timber here is almost all Engelmann spruce, but some good lodgepole pine, range pine (*Pinus aristata*), and *Pinus flexilis* also occur, although rarely used.

The spruce attains a larger size than the other trees in this region. The largest specimens seen and measured showed a total height of 110 or 115 feet and a diameter of 3 feet at the stump. This size is exceptional, however, and the mature timber obtained would probably not average more than 15 inches in diameter at the stump and 70 to 80 feet in height, furnishing 35 or 40 feet of saw logs.

The large trees or those immediately available for the sawmill are interspersed with many too small for present profitable use, but selected acres may be found which would yield 10,000 feet of lumber to the acre by taking trees above 10 inches in diameter at the stump. But when a square mile is taken as a unit the average is greatly reduced on account of lightly timbered areas, burned strips, and the treeless ground or "parks" along the creeks and on the tops of the higher ridges and mountains.

Throughout the remainder of the reserve the best of the timber has already been removed or is in process of removal. A little fair timber occurs at various places along the western arm of the reserve, west of South Park, about Jefferson Lake, on the slopes of Mount Silverheels, and at other points, although the best and most valuable parts of the forest actually lie to the westward, among the mountains, well outside the present boundaries of the reserve. On these outside slopes some very good timber still remains, although in no very extended areas without interruption by poor, burned, cut-over, or open tracts intervening. In this region also the prevailing useful tree is Engelmann spruce, although there is much lodgepole pine mixed with it in some places, or this pine may occupy the ground in some localities almost to the complete exclusion of other species.

Fully three-fourths of the total territory upon which trees grow is occupied by yellow pine and Douglas spruce, among which a small proportion of blue spruce is found along or near creeks, while some lodgepole pine, range pine (*Pinus aristata*), and *Pinus flexilis* occur on the hills. The yellow pine and Douglas spruce prevail over all the eastern half of the reserve and the portion lying south of the Tarryall Mountains. As this ground has nearly all been cut over at various times during the past thirty years, some of it having been twice or even three times searched for suitable sawmill trees, there are few trees of large size remaining. Some of the best trees of these species seen were found north of Lost Park Creek, a few miles from its mouth or junction with the South Platte River, where trees which would furnish from 500 to 1,000 feet of lumber each were scattered over a few hundred acres which had escaped fire and had not been entered by lumbermen, although some had been cut for local ranches. These exceptionally fine trees were surrounded by much timber of undersize or poor quality, and indications seemed to show that forest fire had many years ago burned out smaller trees, leaving a scattered growth of larger ones.

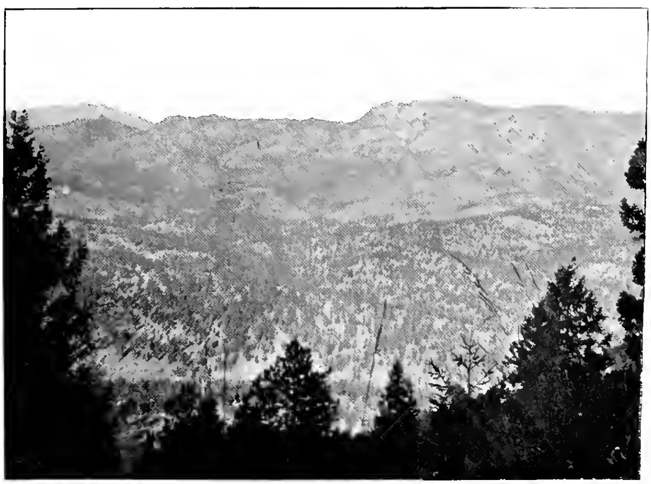
Upon a good deal of the area the yellow pine is more plentiful than the Douglas spruce, and it commonly occurs in very open or scattered growth and well furnished with branches, so that there is but a short, clear trunk. Some trees are ready to be culled out for the sawmill now according to the present standard accepted by the lumbermen, this standard being modified so as to include smaller material as the trees become scarcer and the ground is repeatedly gleaned. A large proportion, however, is too small for any present purpose. In some parts the soil is so rocky, poor, or dry that it is unlikely that the trees upon it will ever reach a large size.

In the southern part of the reserve, west of Florissant, a considerable percentage of blue spruce occurs with the other trees found there, and it is also plentiful in some parts of the reserve bordering South Park.

The lodgepole pine occurs in great abundance on the north and west slopes of the Platte River Mountains, in places through the Park Range, and on some parts of the slopes of Stormy Peak, Freeman Peak, etc. It often occurs almost pure, but it is also frequently mixed with Engelmann spruce, as in the Lost Park region, among the Puma Hills, and along the Park Range. Trees 2 feet in diameter of trunk and 100 feet in height are considered rare throughout this region and although the species is plentiful, or even extremely abun-

A. VALLEY OF TARRYALL CREEK

View southeast from trail from Mountaindale to Bison Peak, at about 11,000 feet altitude



B. VIEW LOOKING WEST FROM ROCK AT GRAHAM'S RANCH 5 OR 6 MILES ABOVE MOUTH OF LOST PARK CREEK

dant in certain sections, there is very little of it large enough to be manufactured into the ordinary kinds of sawmill lumber, as now accepted by the lumbermen. If preserved from damage in future the existing lodgepole pine should eventually yield a considerable amount of medium-sized merchantable timber. This pine seems to be especially susceptible to damage from forest fires, which apparently sweep through a forest of these trees more readily than through growths of any of the other species in this reserve. This is, no doubt, largely due to the resinous character of the tree, to its thin bark and slender twigs, and especially to its dense or close growth when young, several living plants sometimes standing to the square foot until they are several feet high. Standing thus relatively close, the flames easily pass from tree to tree as among dry grass in a meadow.

The lodgepole pine reproduces itself more easily and generally forms a better stand of young trees than any other species. In the case of the yellow pine and the spruces the stand of seedling or young trees is commonly insufficient to produce what would be considered good, clear timber in other regions. Locally, however, as in some gulches and on north slopes, good, fair stands of young trees are found, although they do not cover any very extended continuous areas.

The range pine (*Pinus aristata*) occurs abundantly on many ridges or ranges, particularly on south slopes, but the trunks are generally so short, divided, or covered with large branches, that this tree is seldom cut to be sawed into ordinary lumber, although it is sometimes used for mine timbers.

Pinus flexilis, the limber pine, or white pine, or sugar pine, as it is sometimes called, is not abundant enough anywhere to obtain commercial consideration, although it becomes a much better timber tree than *Pinus aristata*.

Probably at least one-fifth of the total area of this reserve is practically destitute of trees of any kind, excepting in parts where a few widely-scattered pines and small aspens grow in situations where they will not attain arborescent proportions. This treeless area includes bare mountain tops, valleys, or parks between the mountains and along streams, grazing lands included within the present reserve lines, and areas so completely burned that they are not likely to be recovered for a century or two. These irregular treeless areas, the frequent burned tracts, those covered with practically useless kinds of timber (as range pine), the depredations of lumbermen, and the varied character of the so-called wooded ground, make it extremely difficult or almost impossible to get any clear idea of the approximate amount of timber remaining on the reserve. Where lumbermen have already been at work once or twice, they may yet find a good many saw logs of medium or small size, and doubtless several small movable steam sawmills would continue to find employment for several years to come before the available supplies were totally exhausted. Such close cutting, however, would be injurious to true forest interests, because, in open growth of yellow pine and Douglas spruce, the mature trees, or those simply large enough for the mill, should be allowed to remain until the ground has a sufficient number of seedlings upon it for proper restocking of the land. The destruction of necessary seed-bearing trees is often a serious loss in this country, where, in the struggle for existence, so much of the seed is taken by birds and rodents for food, and the conditions of germination are so unfavorable that a smaller percentage of plants results from any given quantity of seed than is the case in other regions, where the conditions are more favorable.

In the region north of the Tarryall Mountains, including what is known as Lost Park and the Kenosha Range and Platte River Mountains, it is probable that 50 million feet of lumber could be taken without serious injury to the forest covering if the work were properly conducted, with due regard to the preservation of the immature growth and the prevention of forest fires. This forest is the best on the reserve and is chiefly composed of Engelmann spruce, which also occurs in considerable quantity on the western arm of the reserve.

The remainder of the ready timber is chiefly yellow pine and Douglas spruce, and altogether the supplies of all properly grown sawmill lumber in the reserve may be placed at 150 million to 200 million feet, although such an estimate is largely guesswork, necessitated by the strangely unequal conditions met with everywhere; and yet it would be impossible to estimate more nearly without a careful measuring and study of each section of ground containing merchantable timber. Doubtless more than the above amount could be immediately cut if the reduced standard of the size of trees taken by the smaller sawmills should be accepted; but a too close and early cutting is often hurtful to the forest and the adjacent country, and is certainly not always the most economical timber management.

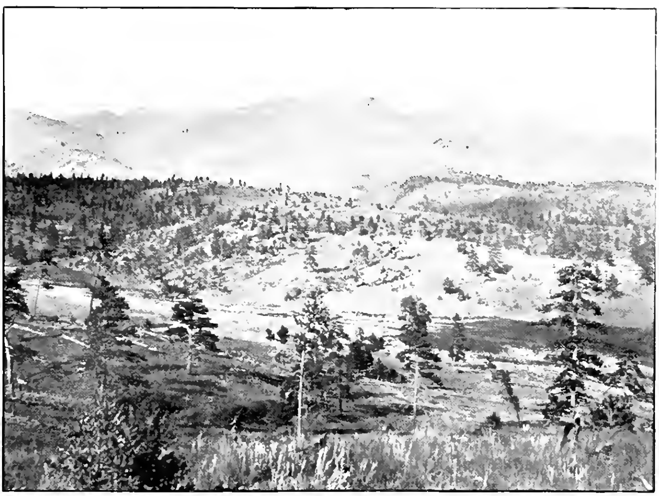
FIRES.

Probably between 60 and 70 per cent of the total forested area of this reserve has damage by fire very clearly marked, and on a larger area there are evidences of ground fires or of forest fires which occurred so long ago that traces of them have become nearly obliterated and a natural forest growth has almost recovered the ground.

The damage by fire is confined to no particular section of the reserve, but spots, streaks, or extended areas of burned ground are frequent on most parts, especially on those longest settled or near routes most traveled, such as long passes through the mountains. The burned tracts are often comparatively small and frequent; but there

A. EAST SIDE OF BRECKENRIDGE PASS, LOOKING SOUTH TOWARD MOUNT SILVERHEELS

Engelmann spruce and lodgepole pine; mostly burnt.



B. VIEW AT MOUNTAINDALE

Looking north across Tarryall Creek to mountains burnt in 1868 or 1869

are three or four areas upon which the burnings have been very extensive.

The most widespread of these conflagrations occurred in 1868 or 1869 and burned over the larger portion of the Tarryall Mountains, which extend northwest and southeast through the central part of the reserve. The burning here was very complete over many thousands of acres, where barely a conifer has yet started to reforest the ground, and the only living woody vegetation consists of small quaking aspen and scattered shrubs of various species.

Sometimes groups or belts of trees escaped, or a whole mountain side was passed unharmed by the flames, and it is from seeds of these living pines and spruces that a new natural forest must be derived.

This fire covered a stretch of mountains over 20 miles in length and 6 or 8 miles wide at the widest parts, although sometimes quite narrow and generally very irregular. It was said to have originated from the burning of a heap of brush by one of the early settlers; but other information placed the responsibility for the fire upon the Indians, who probably are charged with more than their share of such occurrences.

The forest of this burned region consisted chiefly of yellow pine (*Pinus ponderosa*), range pine (*Pinus aristata*), limber or white pine (*Pinus flexilis*), Douglas spruce, and Engelmann spruce.

Lesser fires have more recently occurred in the woods north of the Tarryall Range, many within a few years or since the advent of sawmills.

Large tracts have also been burned on the western arm of the reserve, especially along the slopes east of Weston Pass, and other routes into or over the range.

A great deal of ground shows traces of fire, which must have occurred from thirty to one hundred or more years ago, and upon this is a more or less dense growth of small timber of various ages and sizes, according to the length of time since the fire and the time elapsing before fresh seed stocked the ground. As many of these fires appear to have been comparatively small and local, or to have left living individuals or many intervening strips of living trees which soon produced seed for the burned areas, the ground has become fairly well re-covered, much sooner than is possible when many thousands of acres are burned over and no living trees escape. Almost the only exception to this general rule is found in the case of the lodgepole pine, which, if burned under certain conditions, leaves seed enough unharmed to restock the ground with the same species.

No very extensive fires have occurred on this reserve during the past four or five years, and only one, covering considerable area, was noted during the season when this examination was made. This occured on Breckenridge Pass, on the Colorado and Southern Railway, generally known as the South Park Line, which crosses the reserve at this point. The fire was supposed to have originated from sparks from a locomotive, and it burned one of the snowsheds belonging to the railroad, besides several hundred acres of woodland, in some of which no trace of former fires was evident, although the best of the timber had long since been cut out. This fire burned to timber line or to an altitude of over 11,500 feet, the trees here being chiefly Engelmann spruce, and it reached down to considerable tracts of lodgepole pine. A number of other small fires were burning at this time (October 8) among the timber on both the slopes east and west of the pass. Some of these were presumably started by sparks from locomotives, others perhaps from other causes. They were burning slowly and soon afterwards were extinguished by snowstorms. The railway employees were making no effort to extinguish the fires on the woodland, but the snowsheds were guarded. Near Kenosha Pass, also, grass fires and incipient timber fires were seen, which were started from sparks thrown out by locomotives of the same railway.

SETTLEMENTS.

This reserve is crossed by two lines of railroad. The Colorado Midland Railway crosses the southern portion west of Florissant, following the course of the South Platte River into South Park. The Colorado and Southern Railway, otherwise known as the South Park Line, follows the North Branch of the South Platte River along the entire northern boundary of the main body of this reserve. It leaves this boundary and passes into South Park by crossing the reserve at Kenosha Pass, and the main line again crosses the reserve over Breckenridge Pass, between Como and Breckenridge. Two spurs or branch lines have been built to mines or mining camps located near or outside of the western boundary. One of these runs from Fairplay through Mosquito Gulch to the lower London mine, near the foot of Mosquito Peak. The other branch also starts from Fairplay and follows Horseshoe Gulch to the mining camp of Leavick, formerly known as Horseshoe, located near the eastern base of Horseshoe Mountain at about 10,800 feet altitude.

The amount of land held in private ownership is smaller in proportion to the total area than on either of the other reserves examined. It is chiefly situated in the northeastern and southern parts, and in open grazing areas lying east of South Park.

The largest settlement included within the limits of this reserve is Alma, which is located at the narrowest part of its western arm, at an altitude of above 10,000 feet. It is situated on the Mosquito Pass wagon route, between South Park and Leadville, and has a population estimated at 400 or 500, which is likely to increase or decrease

A. VIEW AT KENOSHA PASS, LOOKING SOUTHEAST

Small aspen, scattered lodgepole pine and Engelmann spruce.

B. LEAVICK, LOOKING NORTHWEST TO MOUNT SHERIDAN

considerably, according to the activity of the mining industries in the adjacent country. Alma is an important supply station for the miners and prospectors in the mountains to the north and west. A smelter is located here, but this was idle during the past summer. Another smelter, also idle, is located near London Junction, which is the railroad station for Alma. Park City, about a mile and a-half west of Alma, has several occupied cabins, but appears to be just outside the reserve limits.

East Leadville, about 6 miles south of Alma, is now nearly abandoned for the active mining camp of Leavick, on the western border of the reserve. The population of Leavick was roughly estimated at perhaps 100 persons, but is likely to vary greatly according to the activity of the mines, amount of timber cutting being carried on, and other industries.

Throughout this region miners' or prospectors' cabins are not rare, but not so numerous as they are on the more mountainous range west of the reserve limits.

In the southern part of this western division of the reserve there are several small ranches, the best known being that called Platte Station, on the route over Weston Pass, at nearly 10,000 feet altitude. Near the summit of this pass there is also a small mining camp.

At the summit of Breckenridge Pass, at Boreas Station, are a number of buildings, chiefly occupied by employees of the railway.

In the main body of the reserve east of South Park the most important settlements are situated along the North Branch of the South Platte River and near Tarryall Creek. Most of the settlements along the former stream are located on its north side and are therefore outside the reserve limits. The largest on the south side is Buffalo, at the mouth of Buffalo Creek, the population of which is estimated at about 150, being very much increased in summer by residents whose cottages are vacant in winter. This land is in control of a regularly organized company known as the Buffalo Creek Park Company.

At Wellington Lake, 7 or 8 miles up Buffalo Creek, there is also established a small colony of summer residents. Cassells, on the North Branch, near Chase, is another summer resort with accommodations for 50 or more persons. South Platte and Estabrook are small stations from which is shipped considerable timber cut on the reserve.

South of Tarryall Creek are several small mining camps. The largest of these is Puma City, which a couple of years ago had a "boom" and a population of several hundred prospectors, but which was reduced to two or three score when seen in the autumn of 1898. Gold City and Jasper are other small prospecting camps.

In the southeastern corner of the reserve and along Wigwam Creek, Lost Park Creek, Tarryall Creek, and the principal creeks of the southern portion are a considerable number of small ranches, with cattle raising as the chief business, but where lumbering and prospecting also usually receive some attention.

Bordenville, on Tarryall Creek, consists simply of two or three ranches, with buildings located comparatively near each other, and at the post-office of Mountaindale, on the same stream, there is a single dwelling with accompanying farm buildings. Weekly mails are received here for other settlers or prospectors who are widely scattered in the region around.

At the post-office known as Rocky, in the southern part, similar conditions prevail, there being no aggregation of inhabited buildings to form a village, but simply a mail center for the scattered population of the country.

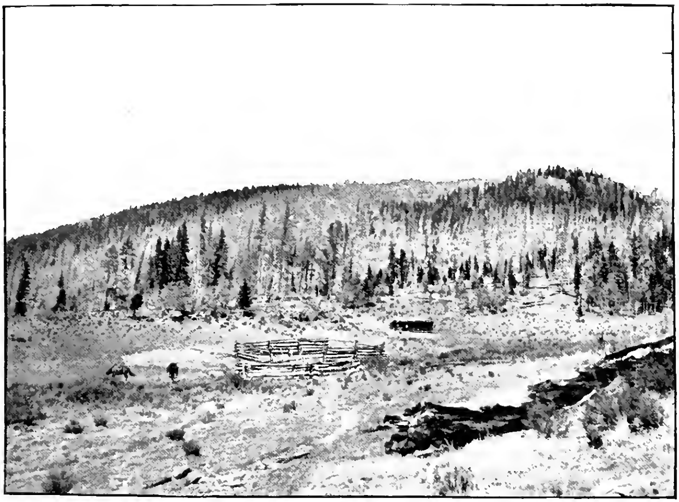
Along the Colorado Midland Railway are five or six small stations within the reserve, rarely composed of more than the dwellings of railroad employees and an occasional ranch. Some attempt has been made to make Lake George a summer resort, but apparently with slight success.

AGRICULTURE AND GRAZING.

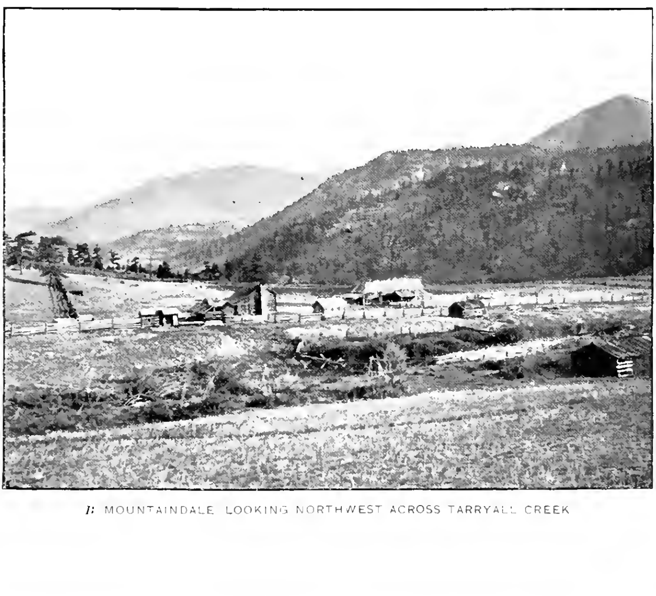
The high altitude of the greater part of this reserve makes the practice of ordinary agriculture impossible. Along some of the creeks, however, especially on the eastern slope at the lower altitudes, some hardy grains are raised and a few potatoes, but the total amount is inconsiderable, and is of no importance in outside markets, although potatoes are taken to Cripple Creek or similar local markets. Potatoes are an uncertain crop, as they are liable to be damaged by late frosts. Hay and grain are the staples cultivated, and what is grown is mostly fed to stock upon the ranches. Stock raising is therefore really the only important agricultural interest, and this would be very limited if stock owners were compelled to graze their cattle on their own lands instead of allowing them to range upon Government territory, as is the general practice.

The patches of cultivated ground are usually so small and irregular that it is difficult to obtain a true idea of the total amount actually tilled, but after a careful estimate it is probably safe to say that the total area of the ground under cultivation in the reserve is less than 3,000 acres, although more may be irrigated and cut over for native hay, but is not cultivated.

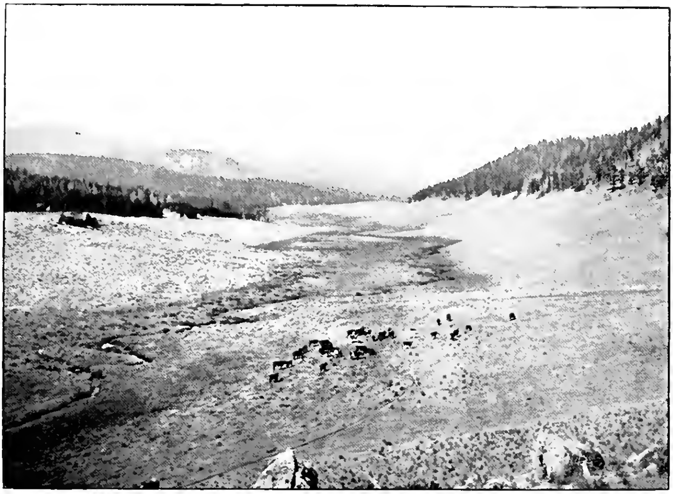
On account of high altitude, narrowness of fertile valleys, and limited water supply it is probable that there will be no very great increase of the profitable tillable area, and the country here must be considered as essentially a grazing one. The large areas of land, covered with a very



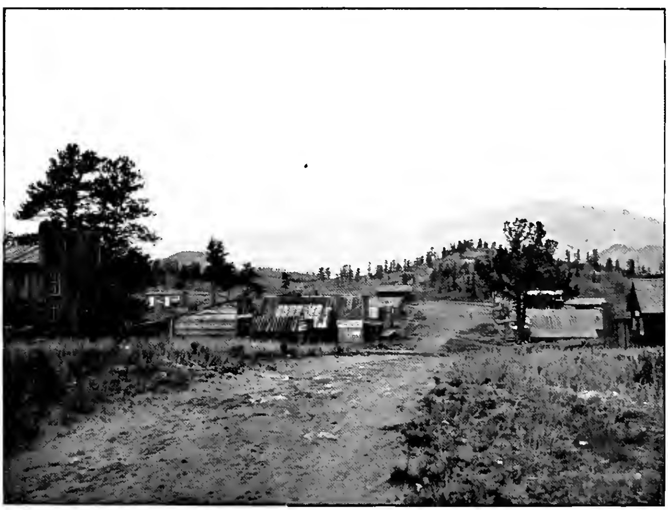
A. HERDSMEN'S CABIN IN LOST PARK. TIMBER BURNT IN [illegible]



B. MOUNTAINDALE, LOOKING NORTHWEST ACROSS TARRYALL CREEK



A. VIEW LOOKING UP LOST PARK CREEK



B. PUMA CITY (TARRYALL POST-OFFICE), LOOKING NORTH THROUGH MAIN STREET

scant growth of timber, produce a scattered growth of grasses and herbage sufficient to furnish food for a limited number of animals.

East of Craig Creek and the Tarryall Mountains it is estimated that from 4,000 to 5,000 cattle have been grazed by the ranchmen during some seasons, but during the past year the number was probably not more than one-half as great because of sales on account of a good cattle market. On all the remaining portions of the reserve it is probable that a maximum of about 5,000 cattle have been kept, the number being subject to great fluctuations in different seasons.

The bona fide residents or settlers of the reserve are not alone in pasturing cattle on public lands, as large numbers of cattle are annually driven in from outside, often the property of persons in no way connected with agricultural pursuits. It was found, for instance, that persons living in Fairplay, on the western side of South Park, made a practice of sending cattle into the Tarryall Mountain region, on the east of the park; and others living at Woodland Park, on the borders of the Pikes Peak Reserve, had herds over 30 miles away in the heart of the South Platte Reserve, to the west. Many of the ranchmen in South Park distribute some of their cattle on the reserve during the summer. Many of these cattle are annually sent into the so-called Lost Park, a region showing more of the original condition of the country and less molestation by human agencies than any other in the reserves. The number annually pastured here is said to vary in different seasons, from several hundred to two or three thousand. When visited in September, 1898, it was estimated that there were then not more than 400 or 500 in that particular region. Cattle belonging to different owners commonly run together, but as they are branded they are easily separated in the autumn "round-up," when they are sent to market or removed to lower altitudes or shelter for wintering. Cattle have been brought hundreds of miles to this region to be temporarily kept until in prime condition for final shipment, or for advantageous markets.

It will thus be seen that it is very difficult to make any close estimate of the number of cattle which the reserve annually supports.

Many sheep are kept on South Park or are brought there to be finally fattened before marketing. During the summer some thousands of them are pastured above timber line on Mount Bross, Mosquito Mountain, and other mountains lying west of the reserve, across which they are driven in order to reach the grazing ground. Little of this sheep pasturage lies within the present boundaries of the reserve. The sheep are usually in charge of herders who temporarily live in cabins near the timber line.

The pasturing of sheep as here practiced is an injury to the sources of the small streams and incidentally to the struggling young trees near timber line. The vegetation of the high mountain slopes becomes badly trampled and cut up by hoofs, as well as reduced by excessive grazing; and in the hollows or ravines, where the streams originate or take definite form, the protective covering of low shrubs, which are chiefly willows, become very much injured or totally destroyed by trampling and browsing, leaving the ground bare and exposed, and liable to be washed away by any heavy rain.

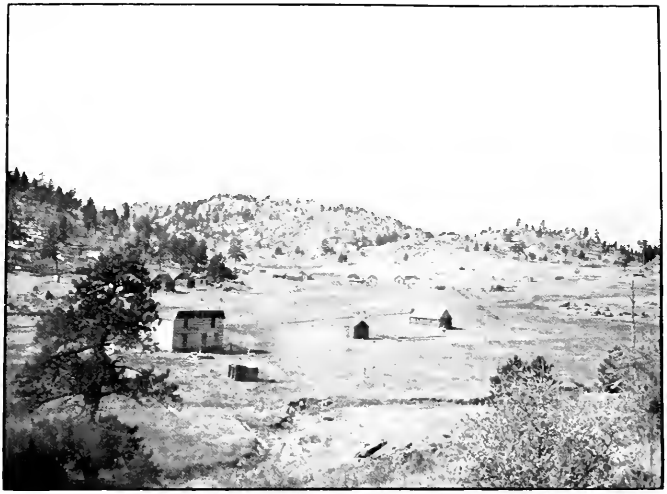
In regard to the pasturage afforded for cattle on those parts of the reserve principally used for grazing purposes, it seems to be the unanimous opinion of the earlier settlers that there has been a very decided reduction of the grazing value of the land as compared with its condition when first used for this purpose. The chief reason is obvious to these ranchmen, who admit that there has been over-pasturage, too many cattle on the same ground year after year trampling it, especially near water, so as to expose the roots of the grasses, keeping the latter as closely cropped as though devoured by grasshoppers, and preventing any possibility of production of seed for regeneration. Unusually dry seasons have also helped to reduce the grazing power of the land, droughts being so serious that it is claimed to have caused the death of mature yellow pines.

The estimated area given as now necessary to support each animal, steer, or cow on these lands varied from 15 to 40 or more acres, which may give some idea of the scanty forage afforded on a good deal of the territory under consideration.

MINING.

Throughout a large part of the South Platte Reserve more or less prospecting has been done, much is still prosecuted, and recently several small new mining camps have been established. The largest of these is Puma City (Tarryall post-office) south of Tarryall Creek, 10 or 12 miles from its outlet into the South Platte. When visited during the past summer the "boom" in this camp had passed, and a large proportion of the buildings were vacant. It was claimed, however, that good ore had been found and only capital was wanted to develop gold mines and make Puma City a thriving place. Since the past summer (1898) rich strikes and a new rush of gold-seekers to this place has been reported, but whether or not there is really cause for excitement has not been settled.

Smaller camps are Gold City and Jasper, both also south of Tarryall Creek, but nearer the South Platte River than Puma City. More or less prospecting is done by most of the ranchmen living on or about the reserves, as well as by persons who give all their time to it. As yet little has been done in the northern part of the main body of the reserve, in the region lying north of the Tarryall Mountains, although



A. GOLD CITY, ABOUT 7 MILES NORTHWEST OF FLORISSANT, LOOKING WEST.

B. ABANDONED SAWMILL SITE ON JEFFERSON CREEK.

the northeastern portion, between Craig Creek and the South Platte, has been more carefully examined.

On the extreme western arm or branch of the reserve lying west of South Park there is considerable activity in mining, both for gold and silver. The reserve limits are here so narrow in part that most of the actual mining ground lies to the west of the present boundaries.

Mount Bross, Mount Lincoln, Mount Buckskin, Mosquito Mountain, Horseshoe Mountain, and other peaks, which geographically should be included within the reserve, are all situated outside of it. On all of these active prospecting and some profitable mining is conducted.

The comparatively old town of Alma lies just within the reserve lines and is an important outfitting post for miners in the adjacent mountains, and flourishes or loses its importance with the rise or fall of mining development in the country about it.

The mining camp of Park City, a few miles west of Alma, also lies just on the reserve borders. It has been partially abandoned for more promising localities.

Some other old but small camps, such as East Leadville and Sacramento, situated within the reserve limits, have been nearly abandoned for more promising localities mostly lying outside the reservation boundaries. East Leadville has been supplanted by the camp known as Leavick or Horseshoe, situated farther up Horseshoe Gulch, at the edge of the reserve and near the base of Horseshoe Mountain, where there is active and profitable gold and silver mining. Farther south, within the reserve limits, on Weston Pass, there is some mining, although it is necessary to haul the ore many miles to mills for treatment.

Few of the operated mines possess proper mills or smelters of their own or in close vicinity, and usually the ore is shipped to some distance, as to Leadville, Colorado Springs, Buena Vista, and other places, to be treated in large establishments. A smelter at Alma and another within 2 or 3 miles of that place have not been working recently.

From most parts of the reserve the ore is either hauled by wagon to the nearest railroad or smelter, or it is brought out over trails on the backs of burros or donkeys, locally known as "jackies." By the aid of these patient and enduring animals the miner without much capital is able to bring ore over narrow trails from places which would be otherwise inaccessible without the expenditure of considerable money in the making of roads or the erection of costly machinery.

At the London mine, at about 12,000 feet altitude, on Mosquito Pass, and at the mines at the head of Horseshoe Gulch, both outside the present limits of the reserve, the ore is brought from high slopes, difficult of access, to the mill or cars in buckets suspended on endless wire rope or cables, no other power than the natural gravity of the laden buckets being required.

In some places wagon roads for hauling ore have been constructed at considerable cost to the promoters.

There is very little placer mining prosecuted within the reserve limits, the most extensive workings being those near Alma and on Tarryall Creek, above Como. During several months in some years these placers can not be worked on account of lack of water. Recently those near Alma have been idle on account of litigation, a too common hindrance to the development of mines and other industries in this part of the country.

There seems to be no doubt as to the permanent richness of the mines in the mountain range to the west of South Park, and the industry is likely to increase.

Profitable mining in the main body of the reserve east of South Park has not yet been proved a permanent and paying business, but there are indications that really good mines may yet be opened there.

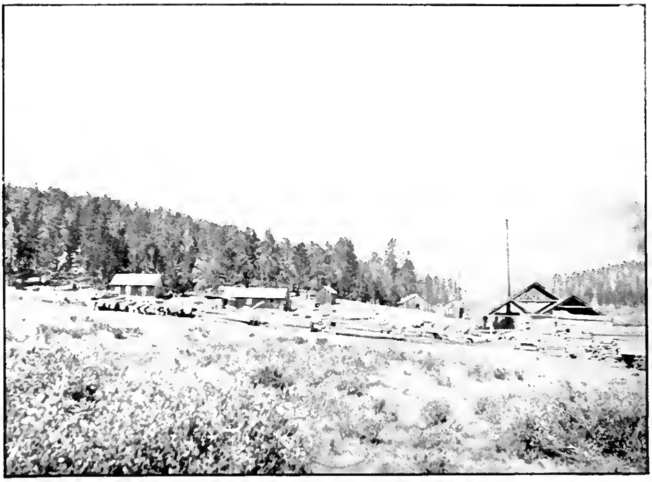
LUMBERING.

Ever since this part of the country was first settled by ranchmen, about forty years ago, the business of cutting lumber from the territory now included within the boundaries of the reserve has been unremittingly prosecuted, although during the earlier years most of the timber cut was for strictly local use. With the advent of railroads and the development of mining the shipping of lumber became important, and numerous sawmills have been almost steadily at work taking timber from private or public lands, legally and illegally. Beginning with the supplies available nearest to market or shipping station, portable sawmills have been moved gradually to the farthest and least accessible of the timbered parts of the mountains, until now they have reached Lost Park, where is located the last of any considerable area of timber land which has not had the best picked from it or been totally destroyed by fire.

The timber nearest the South Platte River and for several miles back from this stream was naturally the first to be taken, and much of this easily accessible ground has been gone over a second time in the search for sawmill logs or for the few railroad ties which might be found.

Abandoned sawmill sites, with their heaps of decaying sawdust and lumber refuse, are plentiful along the courses of the numerous small streams, but at present there are fewer sawmills in active operation than were to be found on this reserve several years ago. This is in part due to exhaustion of supplies in certain localities, and in part to the energy of forest rangers appointed by the Department of the Interior during the past summer.

During the past autumn there were only four or five mills at work



A. SAWMILL AND CAMP IN LOST PARK

B. ENGELMANN SPRUCE UNTOUCHED BY AX OR FIRE NEAR SAWMILL IN LOST PARK NORTH SLOPE.

Altitude above 10,500 feet; trees 3 to 15 inches in diameter of trunk

in the entire reserve. The largest and most important of these was found located in Lost Park, in the midst of the last considerable body of unburned and uncut forest to be found in all this region. When running at full capacity this mill could cut about 25,000 feet of lumber per day. It had been gradually moved from location to location as the good timber was cut out, a very fair lumber road being constructed and extended as necessities arose in order to facilitate the hauling of the product to the shipping station at Estabrook.

It was moved to the present site in the spring of 1893, but was then run for a few months only, when it was closed and not reopened until the spring of 1898. Like many of the larger mills in operation in this part of the country, this one was outfitted by a large lumber company which has extensive lumber yards at Denver, Colorado Springs, and other points. It was claimed by the mill operators that they had title to two sections of land, upon which they were working.

This mill is located beside a small stream in one of the open "parks," at an altitude of about 10,000 feet. The hills and ridges surrounding it are covered with timber of variable quality, according to exposure, and composed mainly of Engelmann spruce, here known as white spruce, which is almost the only tree used for lumber, although some lodgepole pine is cut and mixed with it. The Engelmann spruce reaches its best development on cool slopes having a northerly aspect; on southerly slopes it is poorer and is often supplanted by *Pinus aristata*, which rarely makes good saw logs. The best spruce timber here is not very large, trees 3 feet in diameter at the stump being uncommon, as has already been stated. Most of the logs obtained and sawed are between 12 and 15 inches in diameter at the small end, the trees probably averaging 35 to 40 feet in length of log used after stripping off the branches, as there is commonly a very short clear trunk, or practically none.

The trees are felled by sawing nearly through and wedging the sawed side, so that the tree falls in the opposite direction. The branches are stripped off just so much of the trunk as is considered desirable, usually up to about a foot in diameter at the small end. The timber is cut usually into lengths of 12, 14, or 16 feet, the heavier logs usually into the shorter lengths. Two men generally work together in felling the trees and cutting the logs, although sometimes they are assisted by a "trimmer," whose chief work is to remove the branches from the logs.

Single horses with whippletree and chain are usually employed in hauling the logs to the skids, at the side of a wagon road, where they are loaded upon wagons and taken to the mill. These skidding horses often suffer much injury to their feet and legs, especially where there is much débris from tree tops and branches, and on steep slopes they are liable to be injured by the logs which they are hauling.

The refuse tree tops and branches are left to decay where they fall, furnishing dry fuel, which would cause very destructive burning if fire should get started.

Seedlings and young trees are ruthlessly sacrificed wherever they appear the least in the way of operations, but on most of the ground now being cut over a fair number of medium-sized trees remain to shade and seed the ground and protect the new growth, although many of these trees now left or rejected are liable to fall when visited a second time by the lumberman after gleaning the best from a first cutting, or are sure to be taken when the manufacturer of wood pulp can not get material nearer a shipping station.

Like most of the movable mills in this part of the country, the sawmill in Lost Park is of cheap, rough construction, simply an open-framed building roofed over. One-fourth of the timber is lost in sawdust by the thick circular saw, which consumes a quarter of an inch in thickness with every board cut.

The sawed lumber costs about $3 per 1,000 feet to haul to Estabrook, the nearest shipping station, 14 or 15 miles distant, where it is worth $11 or $12 per 1,000 feet.

Choppers were here paid $1 per 1,000 feet (Scribner's measure) for cutting logs ready for the mill. The lumbermen roughly calculated that 14 or 15 logs of the mixed lengths cut (12, 14, and 16 feet) were required to produce 1,000 feet of lumber.

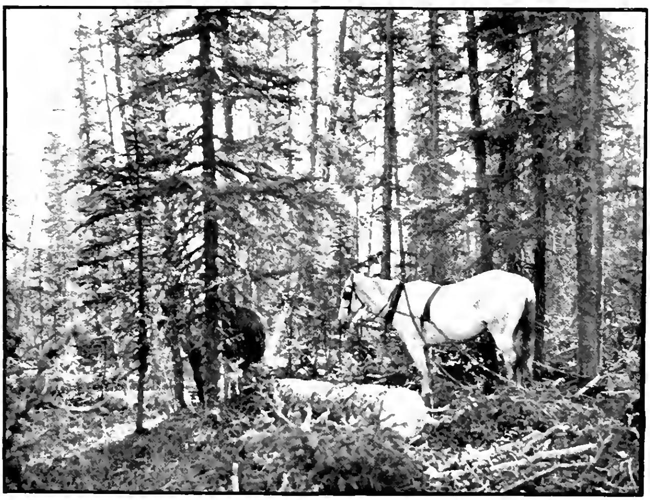
Strong efforts were being made to have the operations of this mill stopped, and at last accounts they were at least temporarily successful.

A sawmill was at work beside a small creek flowing from the Platte River Mountains into the North Branch of the South Platte, near Chase. Another small mill was located near Grant, farther up the river, but on the north or unreserved side of the stream. In October the mill was closed and the proprietor was placed under arrest.

Another mill, with a daily producing capacity of about 10,000 feet of lumber, was at work several miles south of Puma City, About 450,000 feet of lumber was cut from ground within a radius of 2 or 3 miles from the sawmill. At the end of October this mill was moved to another location near Signal Butte, outside the eastern boundary of the reserve. The lumber cut in all this comparatively low country (8,000 to 9,000 feet altitude) is yellow pine and Douglas spruce, and occasionally a blue spruce.

It is here considered worth while locating and operating a portable steam sawmill if 500,000 feet of lumber can be obtained within a radius of 2 or 3 miles, so that the average amount of lumber obtained, around some locations of the mills, is sometimes under 100 feet to the acre. A mill may move to new locations several times in the course of a

A. CHOPPERS FOR SAWMILL IN LOST PARK CUTTING ENGELMANN SPRUCE.



B. HORSES "SKIDDING" SAW LOGS IN LOST PARK.

A TIMBER IN LOST PARK

Three saw logs, Engelmann spruce, together containing over 1,000 feet lumber; largest log 25 inches in diameter at small end. Exceptionally large timber for this region.

B VIEW IN LOST PARK

Logs among refuse, cut and ready for "skidding" out to lumber road.

year, and during the last twenty-five years much of the ground has had two or three visitations from lumbermen. The distance for hauling logs depends somewhat upon the character of roads and the practice of mill managers, some preferring frequent moving of the mill to a long haul of the logs.

One or two small mills were at work near the reserve boundaries south of Florissant.

No active sawmills were found in the western arm of the reserve west of South Park, but three or four were located close to the boundaries. One of these was on the western slope of Breckenridge Pass, another east of Hoosier Pass, near the base of Mount Silverheels, and one close to the eastern boundary of the reserve on the road through Horseshoe Gulch to Leavick. The timber cut by these mills was chiefly Engelmann spruce and lodgepole pine.

At Mountaindale was seen the only water-power sawmill in any of the reserves. Its power was obtained from Tarryall Creek and its output was small, as it is operated only occasionally in order to supply some local demands.

A great many railroad ties have been cut and removed from this reserve, and the cutting of ties is still carried on, although the business is much diminished in comparison with former years. Apparently few ties are cut by regular lumbermen or by persons having tie making for their sole occupation, such cutting as is now carried on being done chiefly by ranchmen, squatters, or prospectors. The work is generally incidental to some other undertaking, and it is almost impossible to obtain any very definite idea of the somewhat limited number of ties now annually cut within the reserves. Douglas spruce is practically the only species cut for this purpose, and to be acceptable to the railroads it is considered essential that it should be cut in autumn or winter, although it was during August and September that the two or three cases of actual tie cutting were observed.

The cutting of Engelmann spruce for manufacture into paper is a comparatively recent industry in this region, but is one likely to grow very rapidly and to the great damage of the spruce forest unless restrictive measures are enforced. No cutting for pulp was actually seen within the reserve lines, although some was reported; but in two places, close to the boundary, timber cut for this purpose was in process of removal from Government land. One of the locations was in Halls Valley, 2 or 3 miles north of the most northerly part of the reserve. The wood is cut into short lengths on the hills and sent down timber chutes to the valley below, whence it is hauled to Webster, a small station on the Colorado and Southern Railway, and there loaded on box cars and shipped to Denver.

Another shipping point was Leavick, near the head of Horseshoe Gulch, so close to the western boundary of the reserve that it was a disputed matter whether or not the work came within the reserve lines. Sticks of any size down to 4 inches in diameter are taken here. The logs are hauled by horses down the slopes to a small steam sawmill, which is used for cutting them into pieces 2 feet long, after which they are loaded on box cars for shipment. A machine for stripping off the bark before shipment was on the ground, but had not been set up or operated.

In the northern part of the reserve, north and west of the Kenosha Twin Cone Mountains, during several years previous to 1893, a large gang of men were employed cutting timber for manufacture into charcoal for smelting purposes. Many thousands of acres were cut over, and practically all of the lodgepole pine and Engelmann spruce were taken to the charcoal kilns, the pine being the principal tree of this section. Twenty-five or thirty kilns were operated, part of them being located at Webster, others near Kenosha.

The timber was taken from public lands and the depredations were stopped only by the establishment of the reserve in 1893. The kilns are now abandoned, some of them broken and fallen to decay, others still in a fair state of preservation.

A great deal of apparently needless destruction attended this cutting. Hundreds of thousands of small lodgepole-pine trees were cut and left on the ground, so as to not only destroy a crop already partly grown, but to invite worse damage by fire. In some places a portion of the small trees was left standing, in others they are gradually coming in to re-cover the ground.

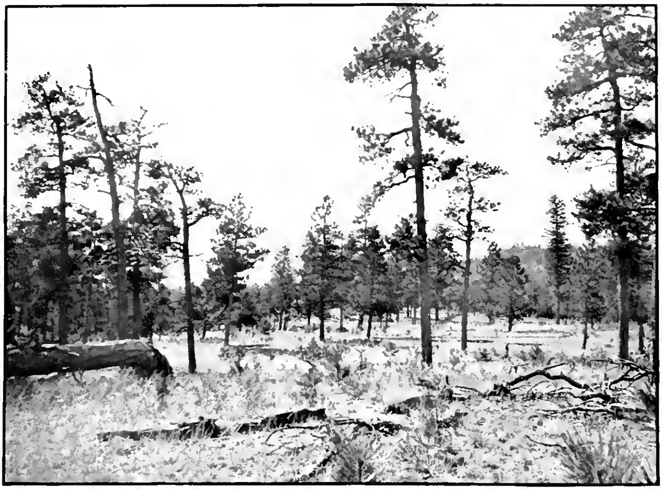
Destructive to forest as the cutter for wood pulp may be, he is outclassed by the manufacturer of charcoal from wood.

Some timber is cut and used locally in mines and a small amount of dead and dry material is collected and sold.

SUGGESTIONS AS TO BOUNDARIES.

As they are at present drawn the boundaries of parts of the reserve are far from satisfactory, especially considering the objects of conservation of timber and water supplies. The irregular artificial boundary lines of certain parts are little known or respected, although natural boundary lines, like the South Platte River, are too obvious to admit of any excuse for trespassing.

On account of the irregularity and narrowness of much of the western arm of the reserve, west of South Park, the timber of almost any part is easily removed by persons outside of the reservation while the reserve lines are in dispute. For the purpose of water conservation the reserve is of comparatively little value. It is unfortunate that the entire eastern watershed of the Park Range of mountains is not included within the reserve, and indeed it would have been advanta-



A. VIEW NORTH OF LOST PARK CREEK 4 OR 5 MILES FROM ITS MOUTH

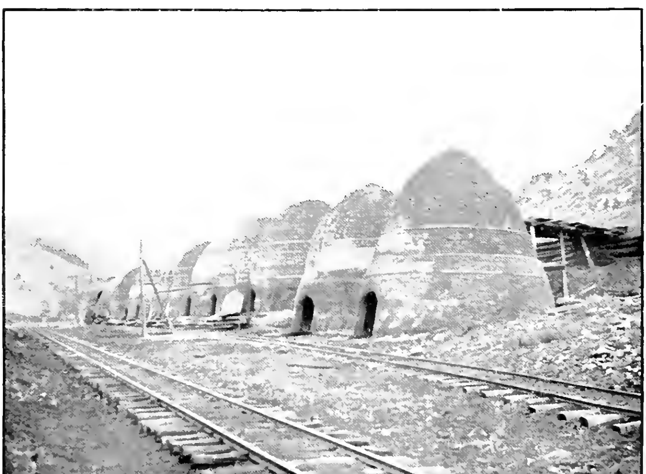
Characteristic growth of yellow pine and Douglas spruce on considerable areas never visited by lumbermen, but subjected to surface fires at various times

B. VIEW AT PUMA CITY LOOKING WEST.

Yellow pine and remnants after cutting

A CHARCOAL KILNS AT WEBSTER FRONT VIEW

Openings are for filling with wood



B CHARCOAL KILNS AT WEBSTER BACK VIEW.

Openings are for taking out charcoal

geous if much of the western slope had been taken in, as here are important feeders of the Arkansas River, and also of the Blue River, which flows into the Grand. It is true that the perpetual snow banks on the sides of these high unreserved peaks are likely to furnish a certain amount of water during the summer, independent of forest conditions on the lower slopes, but the preservation of the forest would be certain to add to the flow of water and to distribute it more evenly in the early part of the summer, when the snows of the lower slopes are melting.

The main body of the reserve would be better and more simply inclosed by making the South Piatte River the boundary along the entire eastern and southern sides, leaving out the territory on the south side of the stream. This ground is not mountainous, and is not of much value as a source of water supply. It is true that it has furnished and may furnish some timber, but in this respect, and also for its small streams, it is not so valuable as a large portion of the unreserved territory lying north of Florissant and Hayden Park, bounded on the east, north, and west, respectively, by the Pikes Peak, Plum Creek, and South Platte reserves. Much of this area, especially on the western side, might well have been included within reservation lines in order to preserve valuable timber upon it and to protect the small tributaries of West Creek and the South Platte River.

There is much territory of an open and almost useless character lying east of the Puma Hills and south of Tarryall Creek, but as it could not very well be separated and may in time become better timbered, it is probably best to continue it as an integral part of the reserve, unless, indeed, it should ever be found advisable to eliminate from the reserve altogether all of the region lying south of Tarryall Creek, this region being of much less value for water conservation than the higher mountain region north of the creek.

West of the Puma Hills and the Tarryall Mountains and east of South Park there are included within the reserve limits considerable areas of open, level, or but slightly timbered and rolling land, which is much used for grazing purposes. As this land is of little use for the purposes for which the reserves were established, it would seem the best policy to relocate the boundaries so that such areas would not come within the rules governing the reservation.

TREES AND SHRUBS OBSERVED IN THE PIKES PEAK, PLUM CREEK, AND SOUTH PLATTE RESERVES, AUGUST, SEPTEMBER, AND OCTOBER, 1898.

The following list of trees and shrubs is undoubtedly incomplete, but there are probably very few more species to be found within the limits under consideration. The list will serve to show the paucity of the ligneous flora of the region examined, embracing over 2,000 square miles in area and varying in altitude from under 6,000 to over 14,000 feet. The list is given alphabetically according to genera.

Abies concolor (Gord.) Parry. (Silver fir, white fir.)

Not abundant. Along streams or canyons up to 8,000 or 9,000 feet.

Abies lasiocarpa (Hook.) Nutt. (*A. subalpina* Engelm.) (Alpine fir or balsam spruce.)

Grows with Engelmann spruce up to timber line. Plentiful in few localities.

Acer glabrum Torr. (Maple.)

Common along creeks and on many mountain slopes, from 6,000 to 10,000 feet altitude. A large shrub, never arborescent, not growing above 20 feet high.

Acer negundo Linn. (See *Negundo aceroides*.)

Alnus tenuifolia Nutt. (Alder.)

A large shrub or small tree, near streams.

Amelanchier alnifolia Nutt. (Juneberry.)

Occasional; from 6,000 to 10,000 feet altitude.

Ampelopsis quinquefolia Michx.

Local, near streams; 6,000 to 7,000 feet altitude.

Arceuthobium. (See *Razoumofskya*.)

Arctostaphylos uva-ursi Spreng. (Bearberry.)

Common on mountain slopes, on coarse granite soils, and prevents washing.

Artemisia tridentata Nutt. (Sagebrush.)

In western part of the South Platte Reserve, with other *Artemisia*.

Berberis repens Lindl.

Common in some localities and on south slopes up to 9,000 feet altitude. Springs up freely from the roots after a fire has passed over the ground.

Betula occidentalis Hook. (Birch, black birch.)

Along streams, up to 10,500 feet altitude or more. A tall shrub, with numerous stems. Never truly arborescent, although sometimes 15 or 20 feet high.

Betula glandulosa Michx.

Along streams and in wet places at high altitudes. A small shrub.

Bigelovia.

There are several species of small shrubby *Bigelovia* in this region.

Ceanothus fendleri Gray.

Observed in Pikes Peak and Plum Creek reserves up to 9,000 feet altitude.

Ceanothus ovatus Desf.

About same range as *C. fendleri*.

Ceanothus velutinus Dougl.

Eastern side of Plum Creek Reserve, 7,000 to 7,500 feet altitude.

A. VIEW ON FISH CREEK, 5 OR 6 MILES SOUTHWEST OF FLORISSANT, LOOKING EAST

B. VIEW LOOKING WEST TO PUMA HILLS, ALONG ROUTE BETWEEN PUMA CITY AND LAKE GEORGE

Timber on hills much burnt

Celtis occidentalis Linn. (Hackberry.)

Rare, only seen on lower eastern slope of Plum Creek Reserve. Small, scrubby.

Cercocarpus parvifolius Nutt. (Mountain mahogany, Buffalo bush.)

Often locally abundant on coarse, granite soils, at altitudes from 6,000 to 9,000 feet. Usually an upright bush 7 or 8 feet high, but never arborescent. When burned, new shoots spring from the stumps.

Clematis ligusticifolia Nutt.

Frequent along creeks under 8,000 feet altitude.

Clematis verticillaris De C.

Occasional, up to 10,500 feet altitude.

Cornus stolonifera Michx. (Red-stemmed cornel or dogwood.)

Occasional, along streams.

Corylus rostrata Ait. (Hazelnut.)

Occasional, on lower slopes of mountains.

Cratægus rivularis Nutt. (Hawthorn.)

This species was found near Grant, on the North Branch of the South Platte River, and along the South Platte near the junction with West Creek. It is apparently rare and local in these reserves.

Cratægus sp.

A thorn bearing some resemblance to but apparently distinct from *C. macracantha* was noticed in the South Platte Reserve on Buffalo Creek, 2 or 3 miles from its mouth. It was hardly arborescent, although there were large, vigorous-stemmed plants, 8 or 10 feet high, accompanied by many suckers. Late spring frosts had destroyed blossoms so that no fruit was produced this season.

Dryas octopetala L.

Low creeping shrub, above timber line, 11,500 to 12,500 feet altitude.

Gaultheria myrsinites Hook. (Wintergreen.)

Plentiful in some localities.

Holodiscus discolor Maxim.

Common on coarse poor soils and rocks up to 10,000 feet altitude or more.

Jamesia americana Torr. and Gray.

Common on rocks and coarse granite soil up to 9,000 or 10,000 feet altitude.

Juniperus nana Willd. (Common juniper.)

Occasional; never abundant. A low spreading shrub.

Juniperus monosperma (Engelm.) Sarg. (Cedar, red cedar.)

Observed only along eastern edge of Pikes Peak and Plum Creek reserves, under 7,000 feet altitude.

Juniperus scopulorum Sarg. (Red cedar; locally also called white cedar.)

More generally distributed through the reserves and growing at a much higher altitude than *J. monosperma*, reaching at least 9,500 or 10,000 feet.

Lepargyraea canadensis (L.) Greene (*Shepherdia canadensis*, Nutt.). (Buffalo berry.)

Local up to 10,500 feet altitude or more.

Lonicera involucrata Banks.

Occasional, especially near streams, reaching to 10,500 feet altitude or more.

Negundo aceroides Moench (*Acer negundo* Linn). (Box elder, ash-leaved maple.)

Seen only along South Platte River in northeast part of Plum Creek Reserve, below 6,000 feet altitude.

Pachystima myrsinites Raf.

Observed only on west slope from Breckenridge Pass, and not actually within reserve limits.

Physocarpus torreyi Maxim.

Common on disintegrated granite soils well up mountain slopes.

Picea engelmanni Engelm. (Engelmann spruce, white spruce.)

The prevailing tree at high altitudes to timber line.

Picea parryana (André) Parry (*P. pungens* Engelm.). (Blue spruce.)

Along creeks and gulches along the lower parts of the mountains and on some of the "parks," up to 10,000 feet altitude.

Pinus edulis Engelm. (Piñon, piñon pine, nut pine.)

Occurs only within the Pikes Peak Reserve north of Manitou.

Pinus flexilis James. (Limber pine, white pine, "sugar" pine.)

Generally scattered through the reserves and reaching to timber line. Rarely abundant at any place.

Pinus aristata Engelm. (Range pine, also miscalled "piñon pine.")

Abundant on south slopes of mountains and reaching to timber line. Also scattered to the base of the mountains and on hills or "buttes."

Pinus ponderosa scopulorum Engelm. (Yellow pine, bull pine.)

The prevailing timber tree up to 10,000 feet altitude. Showing a great deal of variation and hardly considered distinguishable from the typical *P. ponderosa* Lawson, although the variety *scopulorum* is considered distinct by some botanists and is the tree found in this region.

Pinus murrayana Engelm. (Lodgepole pine, white pine.)

Abundant in many regions, either growing with Engelmann spruce and other trees or forming close pure forest of this species alone.

Populus acuminata Rydb. (Cottonwood.)

Only a few trees seen, near Manitou and Colorado Springs.

Populus angustifolia James. (Narrow-leaved cottonwood.)

The most common cottonwood or poplar along streams in this region.

Populus balsamifera Linn. (Balm of Gilead, balsam poplar, cottonwood.)

Frequent along streams; found at altitudes of 10,500 feet or higher.

Populus deltoides Marsh (*P. monilifera* Ait.). (Cottonwood, broad-leaved cottonwood.)

The tree most commonly planted for shade at places along the eastern base of the mountains below 7,000 feet altitude. Not found in the mountains.

Populus tremuloides Michx. (Quaking aspen or quaking asp, aspen.)

Abundant almost everywhere, especially after forest fires. Usually small, but in moist, sheltered canyons or gulches sometimes attaining 60 feet in height and a trunk diameter of a foot or more. Occasionally reaches to 11,000 feet altitude.

Potentilla fruticosa Linn.

This is probably the most generally distributed shrub in the reserves. Observed at different altitudes from 6,000 to 12,500 feet and possibly higher. Often very abundant on open "parks" used for grazing.

Prunus americana Marsh. (Wild plum.)

Local, along creeks on eastern side of Plum Creek Reserve, under 7,000 feet altitude. A shrub or small tree 10 to 12 feet high. The fruit is valued for culinary purposes.

Prunus pennsylvanica Linn. (Bird cherry.)

Common in many places from 6,000 to 10,000 or higher altitude. Always very small, never arborescent. Springs up freely from roots after fire. Possibly a distinct variety or species from the eastern type.

Prunus virginiana Linn. (Chokecherry.)

Frequent, especially along creeks, sometimes on rocky mountain slopes. Usually 6,000 to 8,500 feet altitude.

Pseudotsuga taxifolia (Lam.) Britton (*P. douglasii* Carr). (Douglas spruce, red spruce.)

Abundant, with yellow pine up to 10,000 feet or higher altitude.)

Pyrus sambucifolia Cham. & Schlect. (Mountain ash.)

Rather rare and local.

Quercus gambelii Nutt. (Oak, scrub oak.)

Usually growing to 7 or 8 feet in height, forming thickets. Rarely tree-like or 20 feet high.

Razoumofskya americana (Nutt.) Kuntze (*Arceuthobium americanum* Nutt.).

Parasitic on lodgepole pine; plentiful in some localities and causing considerable injury to the growing trees.

Razoumofskya douglasii (Engelm.) Kuntze (*Arceuthobium douglasii* Engelm.).

Parasitic on Douglas spruce; local.

Razoumofskya robusta (Engelm.) Kuntze (*Arceuthobium robustum* Engelm.).

Parasitic on yellow pine (*P. ponderosa*). Abundant in many localities and sometimes causing much injury.

Rhus glabra Linn. (Smooth sumac.)

Occasional, at low altitudes. Springs up again after fire.

Rhus toxicodendron Linn. (Poison sumac, poison "ivy.")

Occasional; dwarf, never climbing; found only at low altitudes.

Rhus trilobata Nutt.

A common spreading bush in many places from 6,000 to 8,000 feet altitude.

Ribes aureum Pursh. (Missouri currant, buffalo currant.)

Uncommon and local, along streams at lower levels.

Ribes cereum Dougl.

Common on rocks and poor granite soils, on mountain slopes up to above 10,000 feet altitude.

Ribes lacustre Poir. var. **parvulum** Gray.

Frequent, especially at high altitudes, reaching to 12,000 feet or more.

Ribes leptanthum Gray.

Occasional.

Ribes oxyacanthoides Linn. (Gooseberry.)

Along streams up to 9,000 feet altitude or more. Fruit edible; valued for culinary purposes.

Robinia neomexicana Gray.

Naturalized at Manitou from another part of the State. Not within the reserve boundary.

Rosa arkansana Porter.

Rosa engelmanni Watson.

Rosa woodsii Lindl.

The roses showed great variability, and other species may occur. Typical *R. engelmanni* occurs on the Cheyenne Mountain wagon road, between Colorado Springs and Cripple Creek.

Rubus deliciosus James. (Flowering raspberry.)

Common, usually with *Physocarpus*, *Holodiscus*, etc.

Rubus strigosus Michx. (Red raspberry.)

Common in localities, but not so abundant as is generally supposed. Plentiful in a few burned districts and along some roadsides. Always dwarf, rarely more than 18 inches high.

Rubus americanus (Pers.) Britton (*R. triflorus* Richardson).

Uncommon; in moist places.

Salix bebbiana Sarg. (*S. rostrata*, Richardson.)

Occasional.

Salix cordata Muhl.

Frequent along streams.

Salix desertorum Richardson, var.?

Abundant along cold mountain streams or on wet mountain meadows or "parks" reaching 12,000 feet altitude.

Salix flavescens Nutt.

Salix irrorata Anders.

A handsome willow found along streams up to 10,500 feet altitude or more. Grows 8 to 10 feet high.

Salix lasiandra Benth.

Much resembling *Salix lucida* of the east.

Salix longifolia Muhl.

Noticed only along streams below 8,000 feet altitude.

Salix monticola Bebb.

Occasional.

Salix novæ-Angliæ Anders.

Common along streams at high altitudes.

Salix phylicifolia (*S. chlorophylla*, Anders.).

Near streams at high altitudes.

Salix reticulata Linn.

A creeping, very small willow, growing on exposed slopes above timber line.

Sambucus racemosa Linn. (Red-berried elder.)

Occasional on mountain slopes up to 10,500 feet or more. Usually dwarf, and less woody stems than eastern form.

Symphoricarpos occidentalis Hook.

Occasionally abundant, especially near streams.

Symphoricarpos pauciflorus (Robbins) Britton. (Snowberry.)

Plentiful in a few localities.

Symphoricarpos oreophilus Gray.

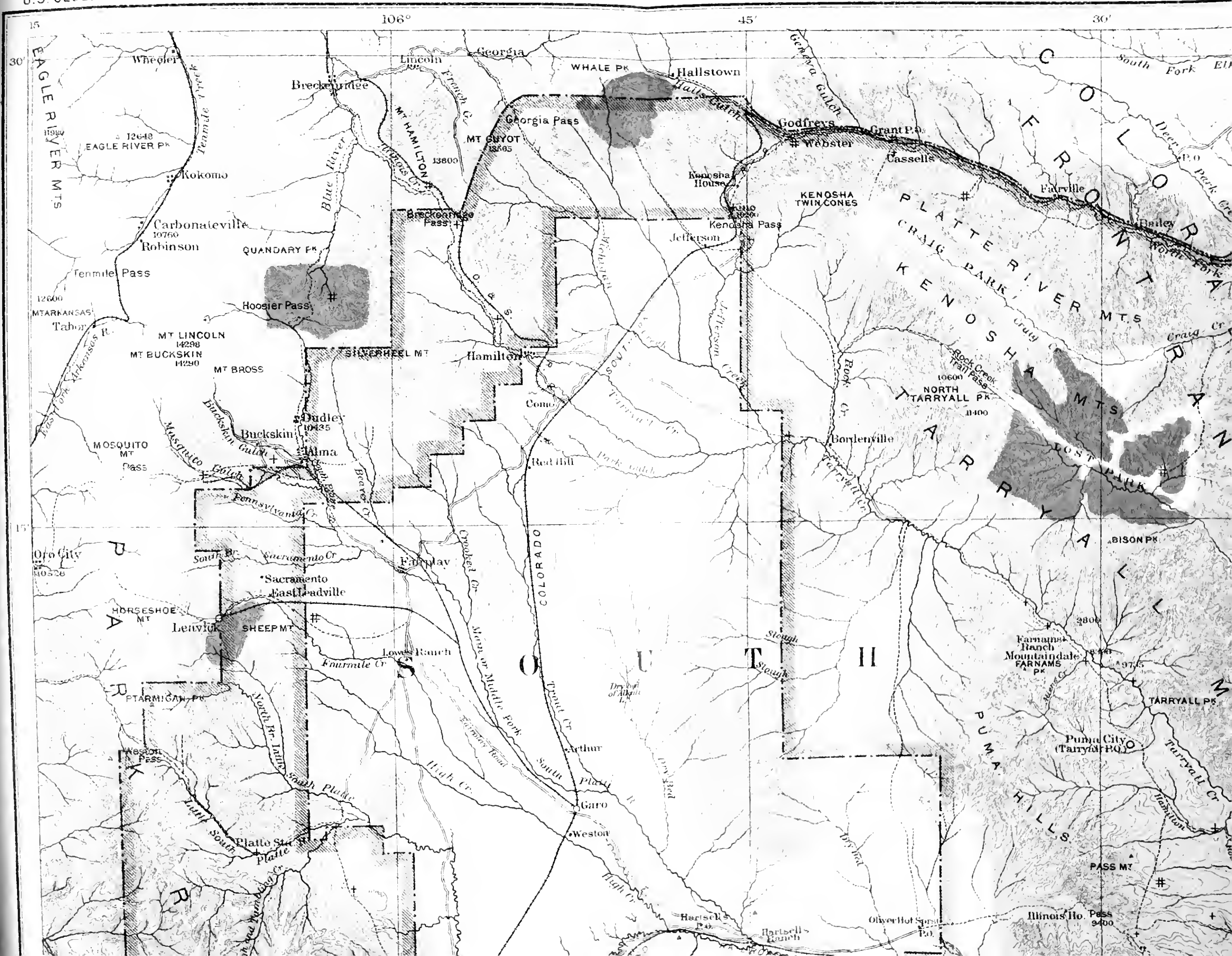
Occasional.

Vaccinium myrtillus Linn, var. **microphyllum**. (Whortleberry.)

Abundant in some localities, but not generally distributed. Dwarf, rarely more than 3 or 4 inches high.

Vitis vulpina Linn. (V. *riparia*, Michx.) (Wild grape.)

Very local along creeks on eastern borders of Plum Creek Reserve at about 6,000 feet altitude.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Wheeler
Lincoln
Georgia
WHALE PK
Hallstown
Breckenridge
Georgia Pass
MT HAMILTON
MT GUYOT
13800
EAGLE RIVER PK
12648
Kokomo
Carbonateville
10760
Robinson
QUANDARY PK
Tenmile Pass
Hoosier Pass
12600
MT ARKANSAS
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MT BUCKSKIN
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SILVERHEEL MT
Hamilton
Como
Dudley
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Alma
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Pass
Red Hill
Fairplay
Oro City
10528
Sacramento
East Leadville
HORSESHOE MT
Leadville
SHEEP MT
Lowes Ranch
PTARMIGAN PK
Weston Pass
Platte Sta
Arthur
Garo
Weston
Hartsels P.O.
Hartsells Ranch
Oliver Hot Springs P.O.
Godfreys
Webster
Grant P.O.
Cassells
Kenosha House
KENOSHA TWIN CONES
Kenosha Pass
Jefferson
Fairville
Bailey
PLATTE RIVER MTS
CRAIG PARK
KENOSHA MTS
Rock Creek Trail Pass
10600
NORTH TARRYALL PK
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Bordenville
LOST PARK
TARRYALL MTS
BISON PK
Farnams Ranch
Mountaindale
FARNAMS PK
TARRYALL PK
Puma City (Tarryall P.O.)
PUMA HILLS
PASS MT
Illinois Ho.
Pass 9400
COLORADO
C O L O R A D O
F R O N T
R A N G E
S O U T H
P A R K
South Fork
Geneva Gulch
Blue River
Tenmile Creek
French Cr
Michigan
Jefferson Creek
Tarryall Cr
Park Gulch
Buckskin Gulch
Mosquito Gulch
Pennsylvania Cr
Sacramento Cr
Beaver Cr
Crooked Cr
Fourmile Cr
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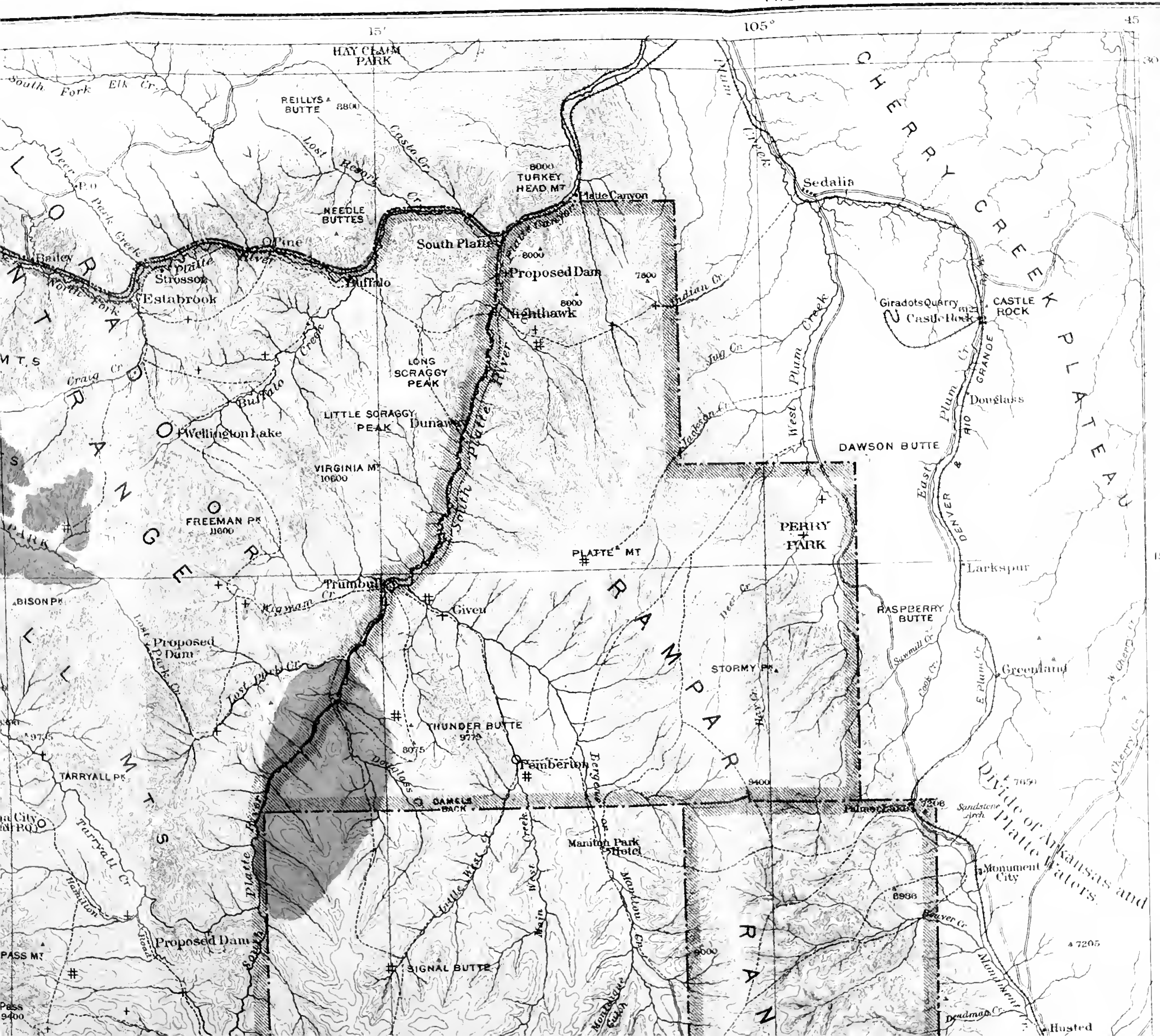
Craig Cr
Rock Cr
Slough
Hamilton
Deer Cr
Dry bed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Casto Cr.
TURKEY HEAD MT
Platte Canyon
NEEDLE BUTTES
Pine
Bailey
Strosson
Estabrook
Buffalo
South Platte
Proposed Dam
Nighthawk
Indian Cr.
Sedalia
CHERRY CREEK PLATEAU
Plum Creek
Giradots Quarry
CASTLE ROCK
Castle Rock
DENVER & RIO GRANDE
Douglass
Jug Cr.
West Plum Creek
East Plum Cr.
DAWSON BUTTE
Jackson Cr.
LONG SCRAGGY PEAK
LITTLE SCRAGGY PEAK
Dunaway
VIRGINIA MT
Wellington Lake
Craig Cr.
Buffalo Creek
FREEMAN PK
PLATTE MT
PERRY PARK
Larkspur
Trumbull
Wigwam Cr.
Given
BISON PK
Lost Park Cr.
Proposed Dam
RASPBERRY BUTTE
Sawmill Cr.
STORMY PK
Greenland
E. Plum Cr.
THUNDER BUTTE
Pemberton
Douglass
TARRYALL PK
CAMELS BACK
Palmer Lake
Sandstone Arch
Divide of Arkansas and Platte Waters
Manitou Park Hotel
Monument City
Tarryall Cr.
Little West Cr.
Main West Cr.
Bergens Cr.
Monument Cr.
Beaver Cr.
Proposed Dam
South Platte River
SIGNAL BUTTE
PASS MT
Deadman Cr.
Husted
RAMPART RANGE
TARRYALL MTS
KENOSHA MTS
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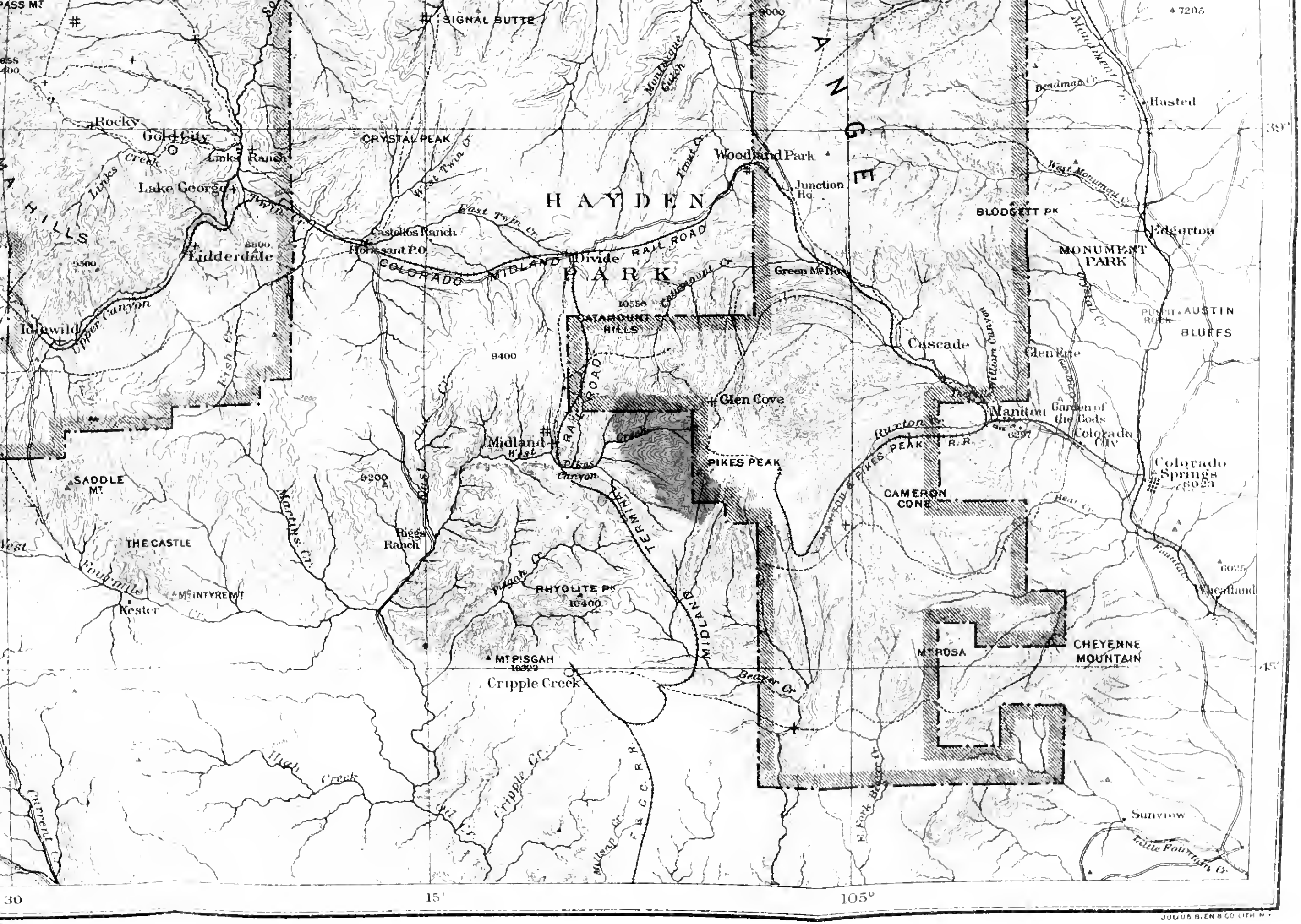
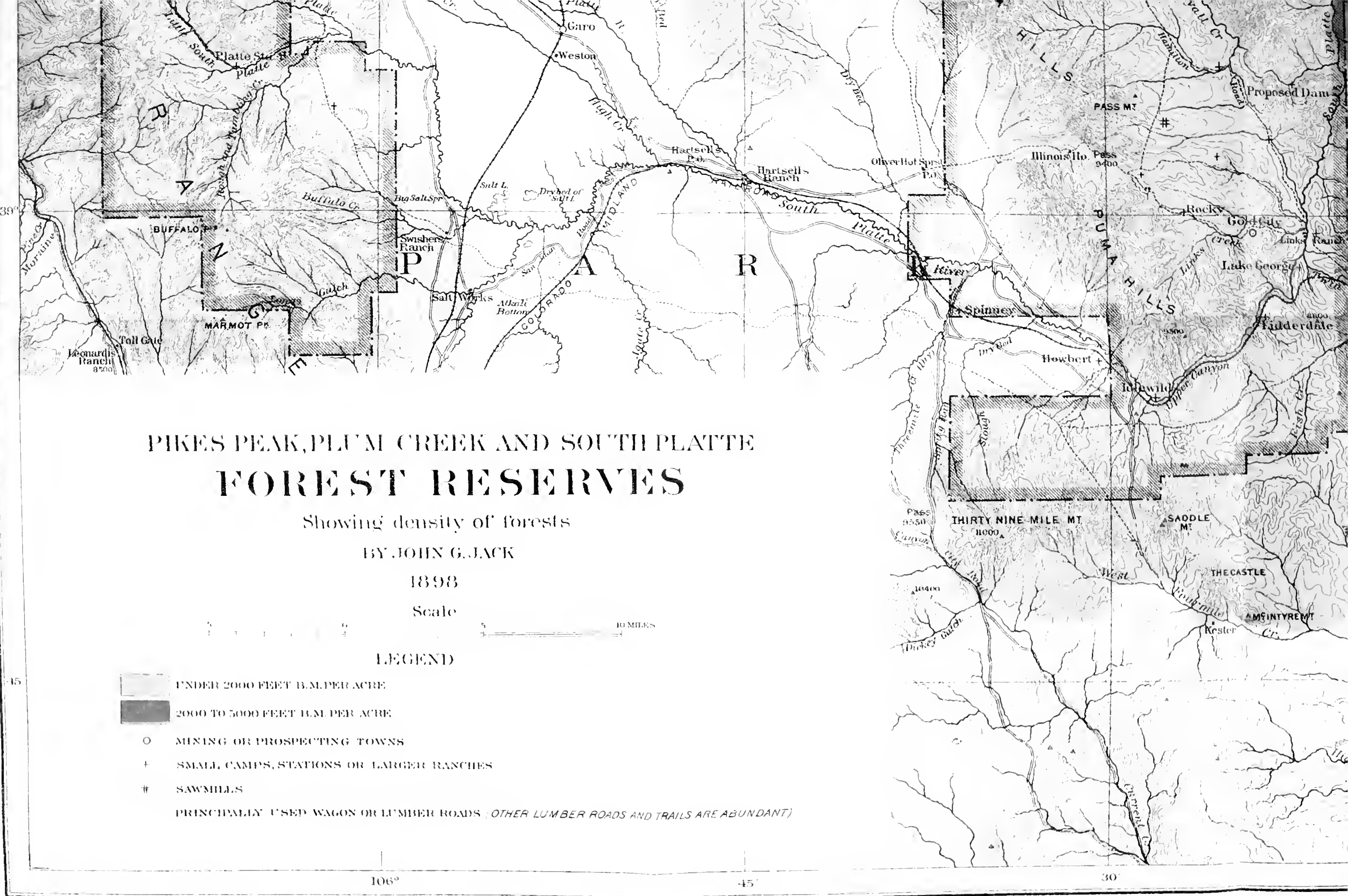
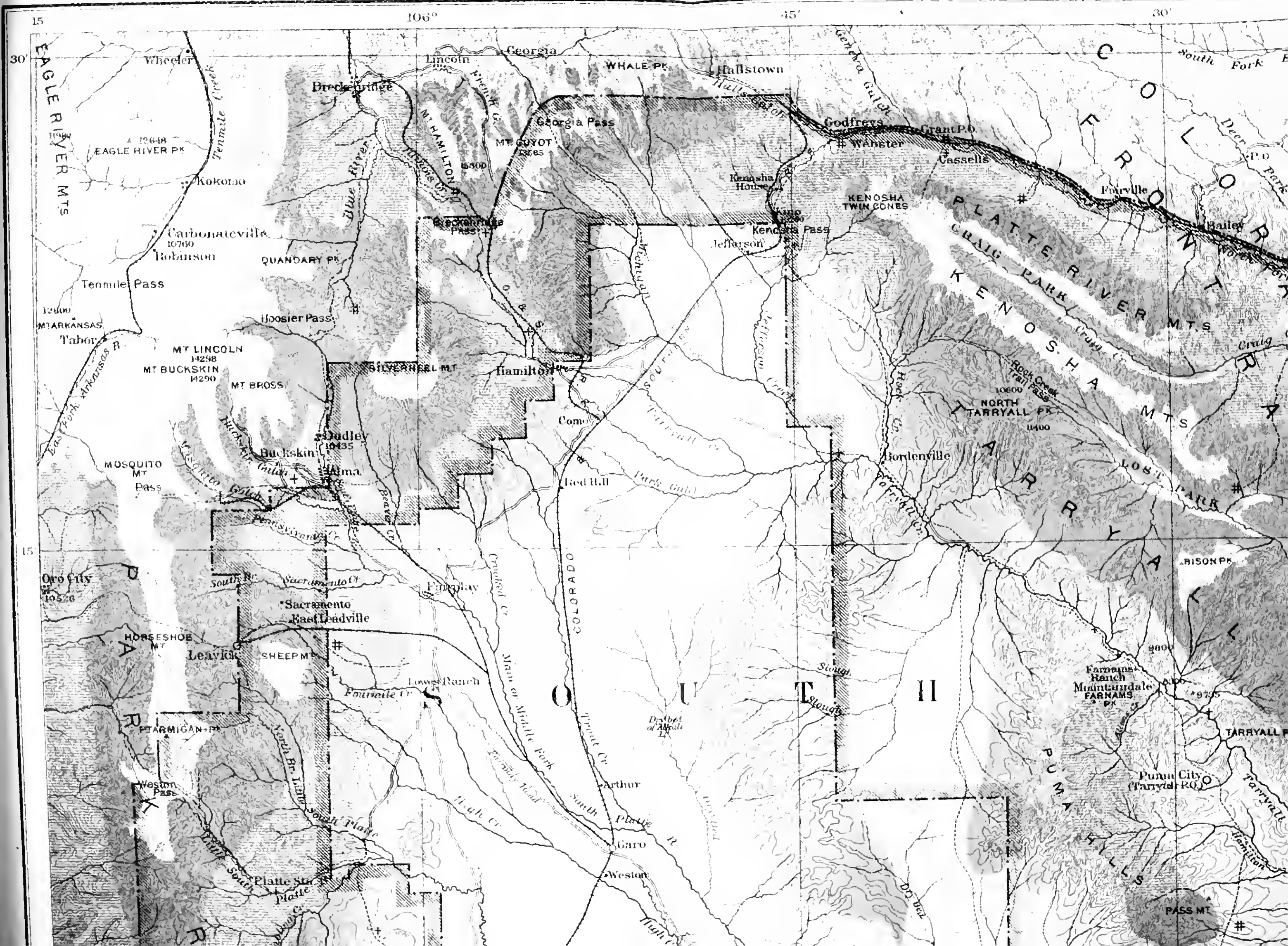


JULIUS BIEN & CO. LITH. N.Y.


PIKES PEAK, PLUM CREEK AND SOUTH PLATTE
FOREST RESERVES
Showing density of forests
BY JOHN G. JACK
1898
Scale
10 MILES
LEGEND
UNDER 2000 FEET B.M. PER ACRE
2000 TO 5000 FEET B.M. PER ACRE
MINING OR PROSPECTING TOWNS
SMALL CAMPS, STATIONS OR LARGER RANCHES
SAWMILLS
PRINCIPALLY USED WAGON OR LUMBER ROADS (OTHER LUMBER ROADS AND TRAILS ARE ABUNDANT)
Garo
Weston
Platte Sta.
Buffalo Cr.
BUFFALO PK.
MARMOT PK.
Toll Gate
Leonardis Ranch
Swishers Ranch
Big Salt Spr.
Salt Works
Alkali Bottom
Hartsells P.O.
Hartsells Ranch
South Platte
P A R K
COLORADO MIDLAND
Spinney
Howbert
Idlewild
Upper Canyon
PASS MT.
Illinois Ho.
Oliver Hot Sprs. P.O.
PUMA HILLS
Rocky
Gold City
Lake George
Proposed Dam
Fidderdale
THIRTY NINE MILE MT
SADDLE MT.
THE CASTLE
MCINTYRE MT.
Kester
Dickey Gulch
Currant Cr.
39°
106°
45'
30'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EAGLE RIVER MTS
Wheeler
Tenmile Creek
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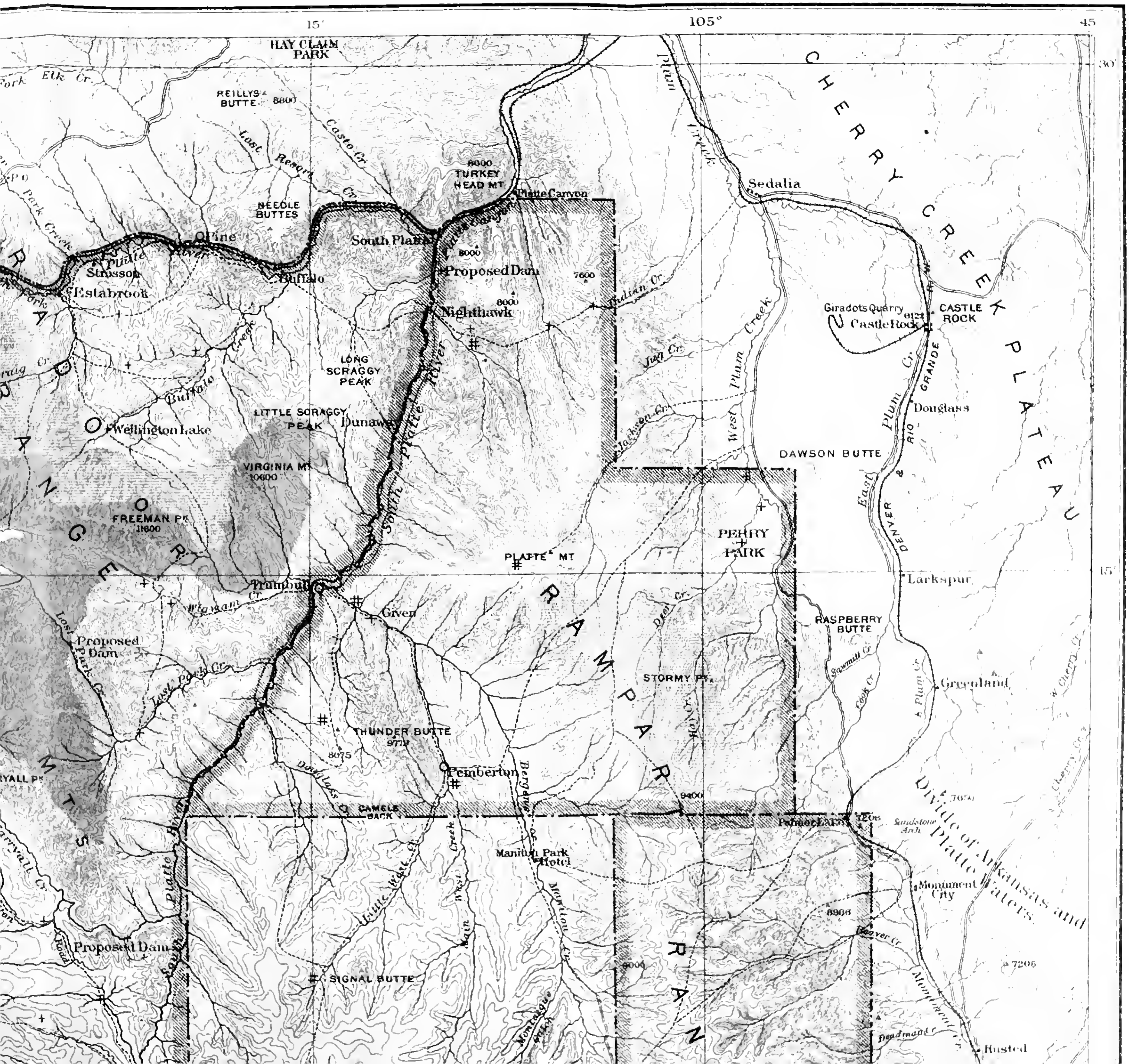
Kokomo
Carbonateville
10760
Robinson
QUANDARY PK
Tenmile Pass
MT ARKANSAS
Tabor
East Fork Arkansas R.
Hoosier Pass
MT LINCOLN
14298
MT BUCKSKIN
14290
MT BROSS
MOSQUITO MT
Pass
Dudley
Buckskin
Alma
Mosquito Gulch
Pennsylvania Cr
Oro City
10520
HORSESHOE MT
Leadville
SHEEP MT
Sacramento
East Leadville
South Br.
Sacramento Cr
Fairplay
Lowes Ranch
Fourmile Cr
PTARMIGAN PK
Weston Pass
North Br. Little South Platte
South Platte
Platte Sta
Lincoln
Georgia
Breckenridge
Blue River
MT HAMILTON
MT GUYOT
Georgia Pass
WHALE PK
Hallstown
Geneva Gulch
Godfreys
Grant P.O.
Webster
Cassells
Kenosha House
Kenosha Pass
Jefferson
Breckenridge Pass
KENOSHA TWIN CONES
SILVERHEEL MT
Hamilton
Como
Red Hill
Park Gulch
Tarryall Cr
Michigan
Jefferson Creek
Rock Cr.
Bordenville
Fourville
Bailey
COLORADO
FRONT RANGE
PLATTE RIVER MTS
CRAIG PARK
KENOSHA MTS
Craig Cr
Rock Creek Trail Pass
NORTH TARRYALL PK
11400
LOST PARK
TARRYALL
BISON PK
Crooked Cr
Main or Middle Fork
Fairplay Road
COLORADO
High Cr
South Platte R
Trout Cr
Arthur
Garo
Weston
Dry bed of Alkali L.
Slough
S O U T H
Farnams Ranch
Mountaindale
FARNAMS PK
TARRYALL PK
PUMA HILLS
Puma City
(Tarryall P.O.)
Tarryall Cr
PASS MT
Dry Bed
Deer Cr
South Fork
P.O.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NEEDLE BUTTES
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Pine
Strasson
Buffalo
Estabrook
Proposed Dam
Nighthawk
LONG SCRAGGY PEAK
LITTLE SCRAGGY PEAK
Dunaway
Wellington Lake
VIRGINIA MT 10600
FREEMAN PK 11600
Trumbull
Given
PLATTE MT
PERRY PARK
STORMY PK
THUNDER BUTTE 9772
Pemberton
CAMELS BACK
Manitou Park Hotel
SIGNAL BUTTE
Sedalia
CHERRY CREEK PLATEAU
Giradots Quarry
CASTLE ROCK
Castle Rock
Douglass
DAWSON BUTTE
DENVER & RIO GRANDE
Larkspur
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Greenland
Palmer Lake
Sandstone Arch
Divide of Arkansas and Platte Waters
Monument City
Husted
RAMPART RANGE
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Plum Creek
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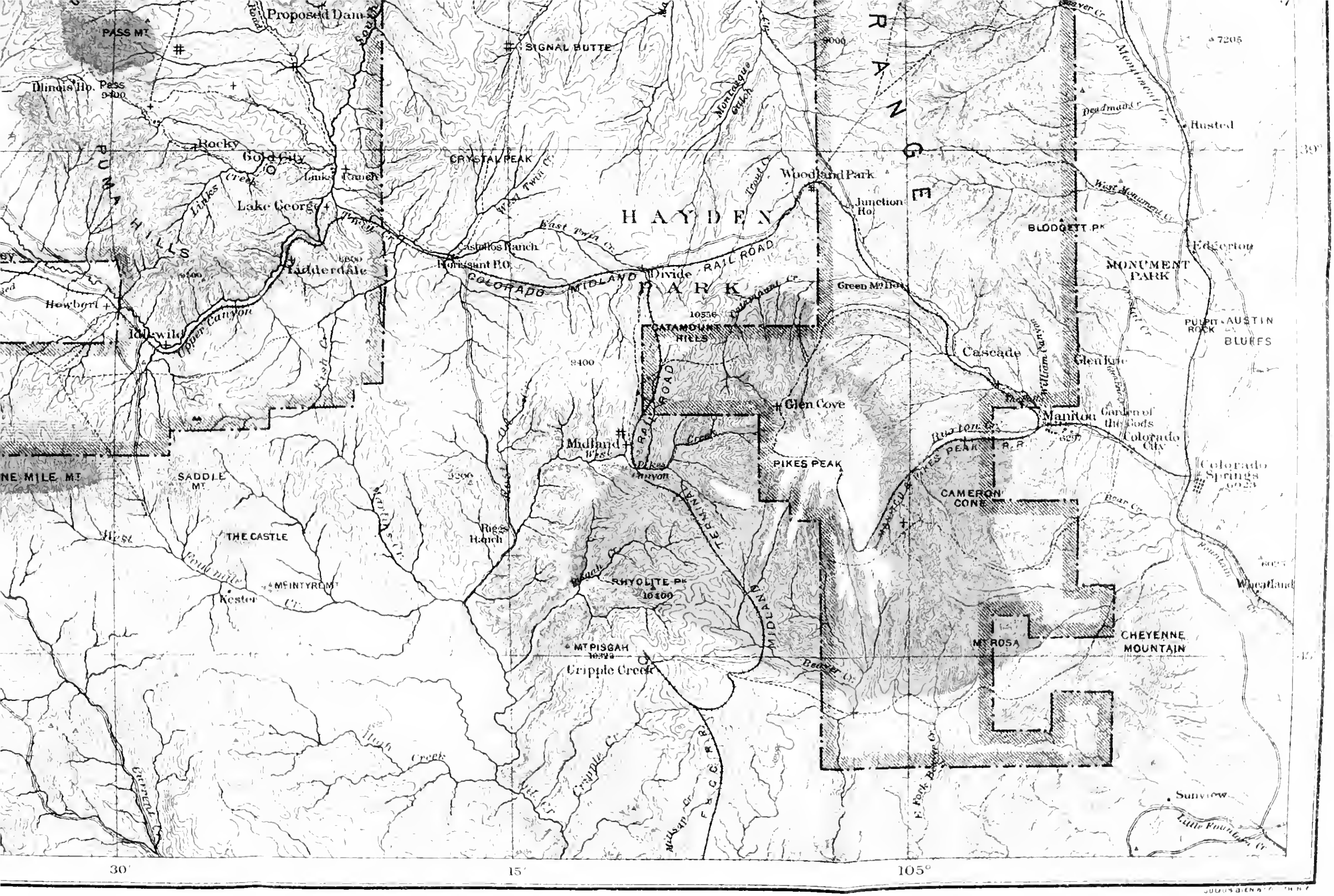

PASS MT
Proposed Dam
SIGNAL BUTTE
Illinois Hp. Pass
9400
PUMA HILLS
Rocky
Gold City
Links Creek
Links Ranch
Lake George
CRYSTAL PEAK
West Twin Cr.
East Twin Cr.
Montague Gulch
Trout Cr.
Woodland Park
Junction Ho.
RANGE
HAYDEN
PARK
Castellos Ranch
Florissant P.O.
Lidderdale
Howbert
Idlewild
Upper Canyon
COLORADO MIDLAND RAIL ROAD
Divide
10556
CATAMOUNT HILLS
Green Mt. Hot.
Cascade
Glen Cove
Midland
PIKES PEAK
Manitou
Garden of the Gods
Colorado City
Colorado Springs
BLODGETT PK
MONUMENT PARK
Edgerton
Husted
West Monument Cr.
Deadman Cr.
Beaver Cr.
7205
PULPIT ROCK
AUSTIN BLUFFS
Glen Eyrie
William Canyon
Ruxton Cr.
MANITOU & PIKES PEAK R.R.
CAMERON CONE
Bear Cr.
Fountain Cr.
Wheatland
CHEYENNE MOUNTAIN
MT ROSA
Beaver Cr.
E. Fork Beaver Cr.
Sunview
Little Fountain Cr.
SADDLE MT
NINE MILE MT
THE CASTLE
Fourmile Cr.
MCINTYRE MT
Kester
Riggs Ranch
RHYOLITE PK
10400
MT PISGAH
10322
Cripple Creek
MIDLAND TERMINAL
Pikes Canyon
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High Creek
Cripple Cr.
F. & C. C. R.R.
Millsap Cr.
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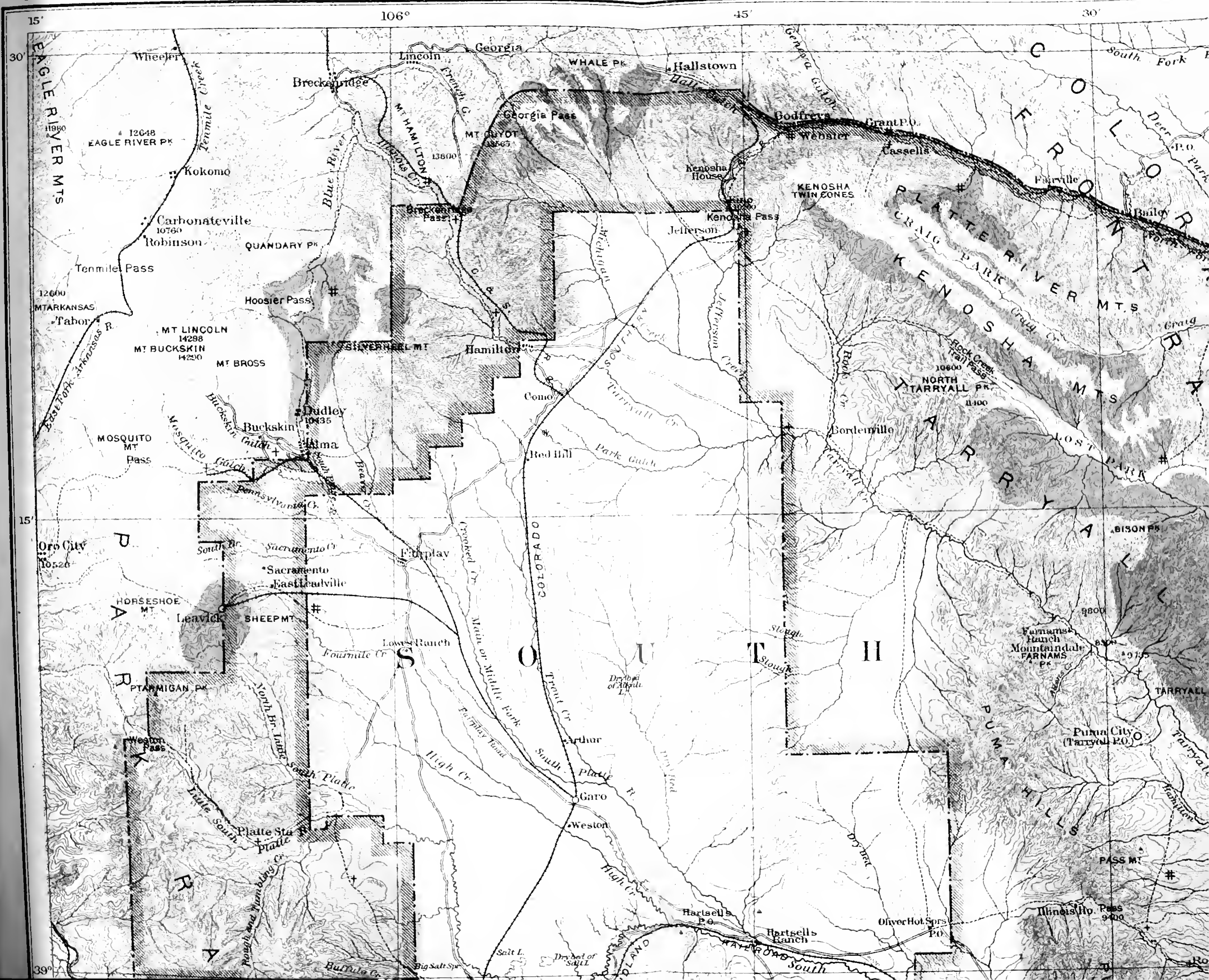
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EAGLE RIVER MTS
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MOSQUITO MT
Pass
Mosquito Gulch
Buckskin Gulch
Buckskin
Dudley
10435
Alma
Pennsylvania G.
Oro City
10526
South Br.
Sacramento Cr.
Sacramento
East Leadville
HORSESHOE MT
Leavick
SHEEP MT
PTARMIGAN PK
Weston Pass
North Br. Little South Platte
Little South Platte
Platte Sta
Rough and Tumbling Cr.
Buffalo Cr.
Big Salt Spr.
Lincoln
Georgia
Breckenridge
Blue River
French G.
MT HAMILTON
Illinois Cr.
13800
Breckenridge Pass
Georgia Pass
MT GUYOT
13565
WHALE PK
Hallstown
Hall's Gulch
Geneva Gulch
Godfreys
Webster
Grant P.O.
Cassells
Kenosha House
Kenosha Pass
Jefferson
KENOSHA TWIN CONES
Michigan
Jefferson Creek
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Tarryall Cr.
Park Gulch
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Beaver Cr.
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COLORADO
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S O U T H
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Dry bed of Alkali L.
Slough
Arthur
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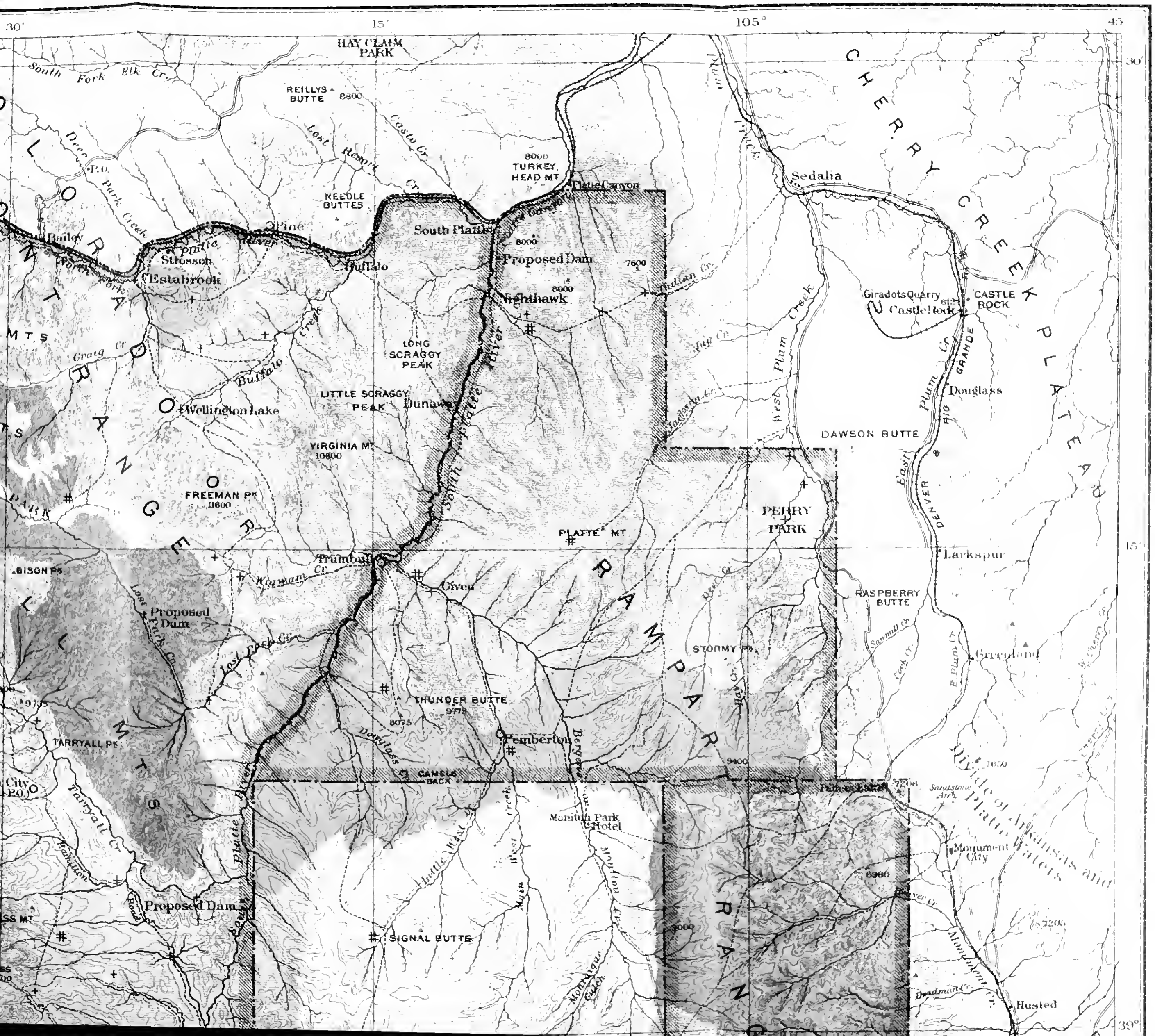
Fairplay Road
High Cr.
Garo
Weston
Hartsells P.O.
Hartsells Ranch
Salt L.
Dry bed of Salt L.
RAILROAD
South
Oliver Hot Sprs P.O.
Dry bed
C O L O R A D O
F R O N T
South Fork
Deer Cr.
P.O.
Fairville
Bailey
North Fork
PLATTE RIVER MTS
CRAIG PARK
Craig Cr.
KENOSHA MTS
Rock Creek Trail Pass
10600
NORTH TARRYALL PK
11400
Bordenville
Rock Cr.
LOST PARK
T A R R Y A L L
BISON PK
9800
Farnams Ranch
Mountaindale
FARNAMS PK
Adams Cr.
TARRYALL
P U M A H I L L S
Puma City
(Tarryall P.O.)
Tarryall
Hamilton
PASS MT
Illinois Ho. Pass
9400



30'
15'
105°
45'
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39°
HAY CLAIM PARK
South Fork Elk Cr.
REILLYS BUTTE 8800
Deer Creek
Lost Resort Cr.
Casto Cr.
NEEDLE BUTTES
8000
TURKEY HEAD MT
Platte Canyon
Sedalia
CHERRY CREEK PLATEAU
Bailey
Pine
Strosson
Estabrook
Buffalo
South Platte
Proposed Dam
8000
7600
Nighthawk
Indian Cr.
Giradots Quarry
CASTLE ROCK
Castle Rock
MTS
Craig Cr.
Buffalo Creek
LONG SCRAGGY PEAK
West Plum Creek
GRANDE
Douglass
Wellington Lake
LITTLE SCRAGGY PEAK
Dunaway
South Platte River
DAWSON BUTTE
VIRGINIA MT 10800
FREEMAN PK 11600
PLATTE MT
PERRY PARK
DENVER
East Plum Cr.
Larkspur
BISON PK
Trumbull
Wigwam Cr.
Given
COLORADO RANGE
RAMPART RANGE
Lost Park Cr.
Proposed Dam
RASPBERRY BUTTE
Sawmill Cr.
Greenland
STORMY PK
THUNDER BUTTE 9778
8075
TARRYALL PK
TARRYALL MTS
Douglass
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CAMELS BACK
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8966
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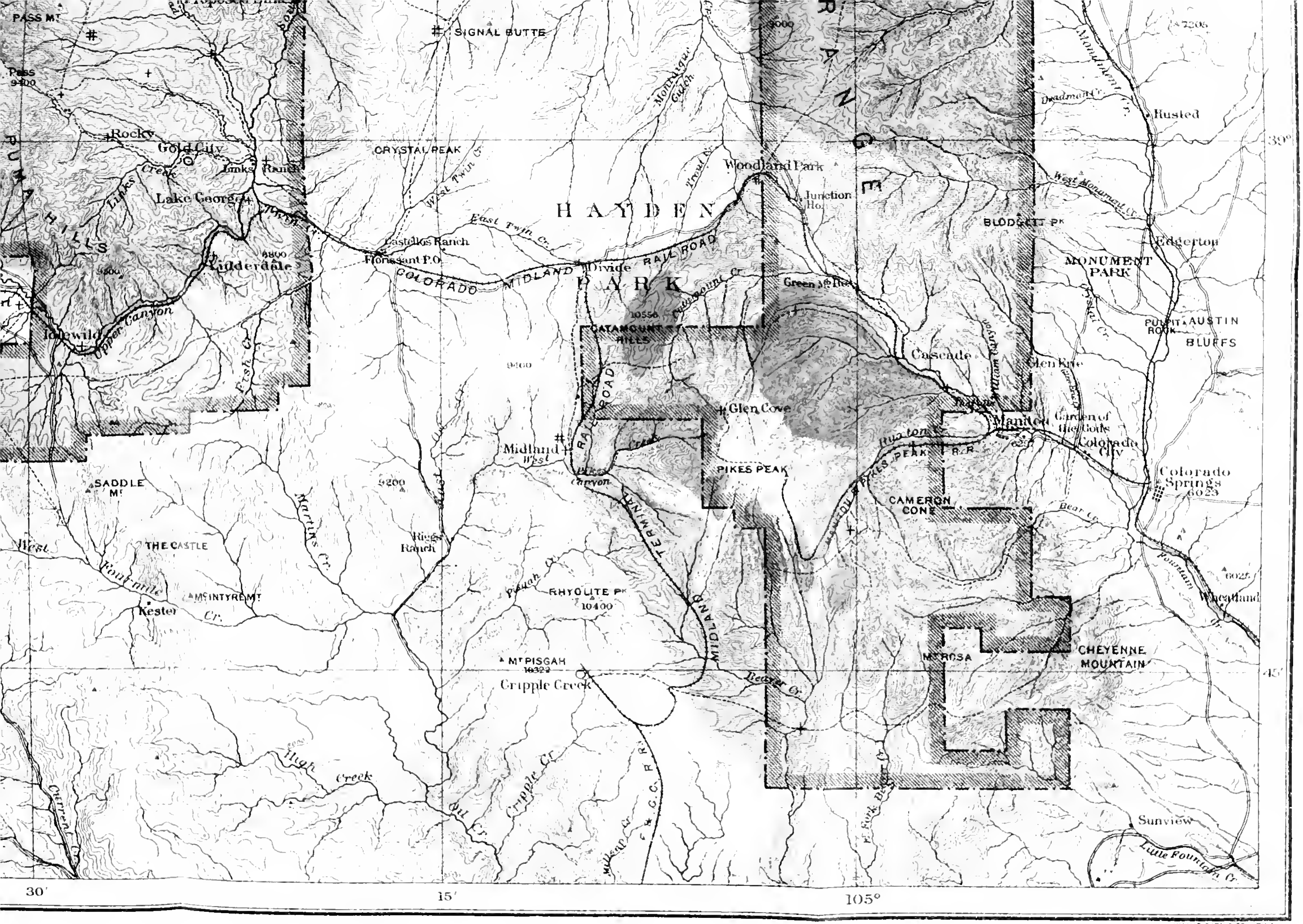
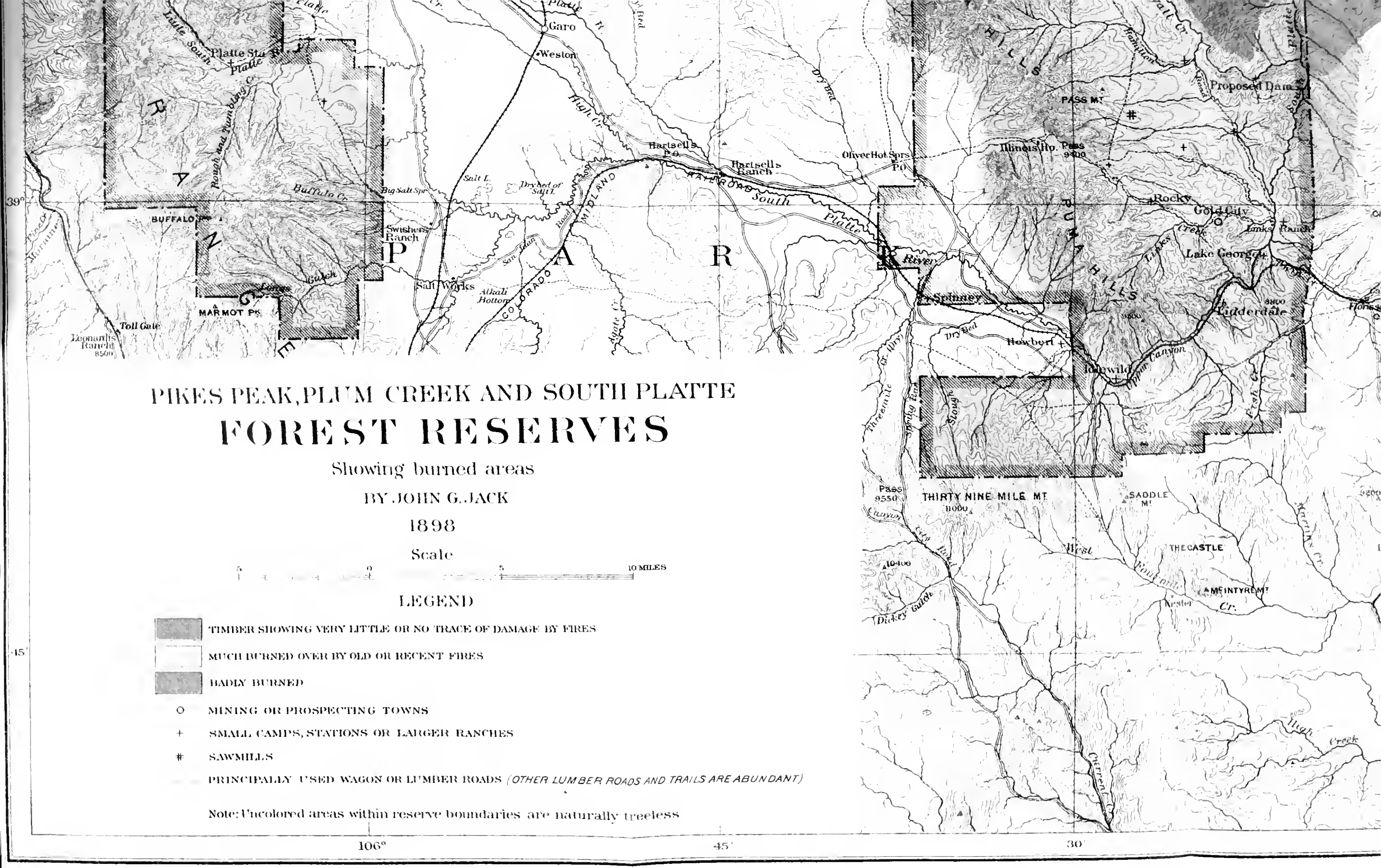
Main West Creek
Manitou Road
Proposed Dam
SIGNAL BUTTE
Monument Cr.
Dead Man Cr.
Husted



JULIUS BIEN & CO LITH N.Y.


PIKES PEAK, PLUM CREEK AND SOUTH PLATTE
FOREST RESERVES
Showing burned areas
BY JOHN G. JACK
1898
Scale
5 0 5 10 MILES
LEGEND
TIMBER SHOWING VERY LITTLE OR NO TRACE OF DAMAGE BY FIRES
MUCH BURNED OVER BY OLD OR RECENT FIRES
BADLY BURNED
MINING OR PROSPECTING TOWNS
SMALL CAMPS, STATIONS OR LARGER RANCHES
SAWMILLS
PRINCIPALLY USED WAGON OR LUMBER ROADS (OTHER LUMBER ROADS AND TRAILS ARE ABUNDANT)
Note: Uncolored areas within reserve boundaries are naturally treeless
Garo
Weston
Hartsells P.O.
Hartsells Ranch
Oliver Hot Sprs P.O.
Proposed Dam
PASS MT
Illinois Ho.
Rocky
Gold City
Lake George
Lidderdale
Idlewild
Spinney
Howbert
Salt Works
Swishers Ranch
BUFFALO
MARMOT PK.
Toll Gate
Leonards Ranch
THIRTY NINE MILE MT
SADDLE MT
THE CASTLE
McINTYRE MT
South Platte
COLORADO MIDLAND
P A R K
106°
45'
30'
39°
15'


U.S. G
15'
30'
EAGLE RIVER MTS
Cr.
Estal
12600

DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

THE

PRIEST RIVER FOREST RESERVE

BY

JOHN B. LEIBERG

EXTRACT FROM THE NINETEENTH ANNUAL REPORT OF THE SURVEY, 1897-98
PART V, FOREST RESERVES—HENRY GANNETT, CHIEF OF
DIVISION OF GEOGRAPHY AND FORESTRY

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PRIEST RIVER FOREST RESERVE.

By John B. Leiberg.

INTRODUCTION.

The data on which this report is based were in part obtained during several preliminary trips along the eastern and southern portions of the reserve during the months of May and June, and in part during the month of July and the first half of August, 1897, when the reserve was traversed from north to south along three different routes, with frequent crossings from east to west.

In a region so difficult of traverse as the Priest River Reserve, and without areal surveys to guide in determining superficial contents of the several tracts, it is not to be expected that every small subdivision has been examined in detail in the brief time allotted to the work, nor that the average estimate is absolutely exact. A general summary of the conditions is all that has been attempted. It is believed, however, that all estimates are conservative and approximately correct. An absolutely accurate account can not be had until the entire area shall have been surveyed and subdivided, and each quarter section successively examined—a labor that, even on the comparatively small area embraced within the limits of the reserve, would require the work of several seasons.

TOPOGRAPHY.

The Priest River Forest Reserve as at present delimited consists of the drainage basin of Priest River, a stream having its ultimate head at or slightly beyond the forty-ninth parallel and flowing in a southerly direction to a junction with the Pend Oreille River, together with a small area in the immediate valley of the Pend Oreille. It is situated mainly within the borders of the State of Idaho, in Kootenai County, a small portion of the western area extending beyond into the State of Washington.

It is essentially a mountain region, the flat or approximately level tracts probably not forming more than 12 to 14 per cent of the whole. In elevation it varies from 2,000 to about 8,000 feet, the mean being about 3,800 feet above sea level.

The long diameter of the basin is from south to north, being rather more than 55 miles; the short one, from east to west, has an average width of about 20 miles. Its position presents a broad opening toward the south and southwest, an ideal one in this region to insure a heavy yearly precipitation over the entire area, and as a result a dense forest growth. The region is limited on the east and west by two north-south mountain ranges, which converge at their northern extremities and form the head of the basin, but recede from each other toward the south. The eastern range is here named the Priest River Range; the western one the Pend Oreille Range. From each of these primary ranges secondaries project far into the basin, and by repeated subdivision nearly fill it with a rugged mass of spurs and ridges.

The Priest River Range is the loftier. Its central regions are the most elevated; the sinuous crest line of the backbone maintains an altitude between 5,000 and 6,000 feet for the greater portion of its length, rising in some localities to about 8,000 feet. Its rock formation consists of hard but much fissured granites and syenites, with occasional areas of slates and gneisses along the southern extremity. It has been deeply sculptured and eroded by glacial action, creating deep canyons and wearing the crest in many localities to a mere narrow margin between great precipices on either side.

The Pend Oreille Range, which incloses the basin on the west, forms the divide between Pend Oreille and Priest rivers. It is much less rugged than the Priest River Range and has a less elevated crest line, rarely rising above 6,000 feet. It is mostly composed of schistose rocks, traversed more or less by granitic extensions from the eastern areas. Owing to the softer materials composing its rocks, the lines of erosion are more rounded, presenting longer slopes that incline toward the central depression with angles much less acute than is the case with the Priest River Range. The troughs between the lateral ridges are broader, less canyonlike, forming flat, often swampy valleys with lake-like expansions that occasionally hold small ponds. The diversity in rock formation, with consequent unequal sculpturing and erosion, divides the basin into two areas with very dissimilar topographical features and of different degrees of economic importance. The present shape of the basin is largely due to the pressure and wear of a large glacier that once filled the basin. It appears to have originated in the high eastern range, moving thence toward the west, and eventually sliding southward into the Pend Oreille Valley. The hard granitic areas on the east were cut into steep spurs and narrow, deep canyons, while the softer schistose ridges on the west, offering less resistance, were extensively ground down and the depressions between them filled with glacial débris, forming broad flats and valleys. Upon the permanent recession of the glacier a lake occupied a large portion of the basin, submerging the low areas, depositing a lacustrine sediment, and thereby further smoothing out the surface of the valleys. The lake has gradually dwindled in size, due in part, perhaps, to the removal of a terminal moraine at the south end of the basin, in part, certainly, to the channel excavated by Priest River to its junction with the Pend Oreille

A. A PORTION OF THE PRIEST RIVER DIVIDE LOOKING WEST.

B. PRIEST RIVER AT ITS OUTLET FROM LOWER PRIEST LAKE

through the mass of glacial débris along its course, and in part, not unlikely, to a continued uplift of the rocks forming the basin. Since the disappearance of the glacier and after the rapid drainage began, the valleys have been more or less excavated by their shifting drainage channels, causing the terraced formation which we now find.

The drainage system of the basin consists of Priest River, the principal stream, with several large forks and numerous smaller tributaries as feeders. The two upper main forks of the river are about 10 miles in length. They head partly in the angle of convergence formed by the two great north-south divides that inclose the basin and partly in the northern portion of the west range. The western of these forks is named Gold Creek; the eastern is considered as the upper portion of Priest River. About 3 miles below the junction of the two forks the stream enters Upper Priest Lake, a shallow sheet of water about 2 miles long and 1 mile wide. At its southern end it is connected with Lower Priest Lake through a somewhat tortuous channel, named the Thorofare, about 2 miles long and varying in width from 75 to 120 feet. A sluggish current runs through this channel, which has a depth of 2½ to 12 feet at medium stage of water. Lower Priest Lake is about 18 miles in length and from one-half to 5 miles in width. Its position is nearly on the dividing line between the two rock formations of the basin. The eastern shore is bold and rocky, rising rapidly by steep encarpments and spurs to the summit of the main divide. The spurs and ridges that form the western shore are mostly low and are broken at frequent intervals by broad valley openings and swampy areas stretching westward. The lake serves as a central reservoir and receives about 65 per cent of the entire drainage of the basin. There are no data obtainable as to its depth. The deepest portion is evidently east of the center line. Numerous shallow gravel, sand, and bowlder bars project far out from the western side, especially at the outlet of the various creeks. The lake contains six islands. Three of these are merely the projecting tips of rock spurs still submerged. The others are larger, but none are of any economic importance. The outlet of the lake is by Priest River, which leaves it at the southwest corner through a channel about 400 feet wide and averaging about 3 feet in depth at medium stage of water. The course of the river to its junction with the Pend Oreille is generally southward, with a length of about 32 miles. A number of tributaries enter along the way, the most important being the upper and lower West Forks from the west and the East Fork from the east.

The current is swift, especially in the lower one-third of its length, where there exists a series of rapids extending a distance of 7 miles. These rapids are mainly due to huge bowlders dropped into the bed of the river by its excavation through the moraine material. The total fall in the river from the outlet in the lower lake to its junction with the Pend Oreille is about 600 feet. At the point of junction, or about one-third of a mile above, it is nearly 300 feet wide, with a depth in midchannel of about 7 feet at its summer stage and a current of between 2 and 3 miles an hour. The valley of Upper Priest River is a mere narrow canyon for about 10 miles of its length, as is that of its principal upper fork, Gold Creek. Below the junction of this fork to the head of the upper lake the river flows through a low swampy valley about three-fourths of a mile wide.

The valley below the lower lake has a width varying from about 2 to 4 miles. Low isolated ridges rise here and there, their bases buried in the mass of glacial detritus that has filled up the inequalities and approximately leveled the area that now constitutes the valley. Through this mass of transported material the stream has cut its way, excavating a channel that at the present time varies from 20 to 150 feet in depth from the water line to the top of the inclosing banks.

WATER SUPPLY.

The reserve is situated within one of the zones of heavy precipitation in northern Idaho. Just how great the annual precipitation is we do not know, no data being obtainable in regard to it, but that it is exceptionally heavy is proved by the enormous development of the arborescent flora of the region. It is probable, however, that it lies between 50 and 60 inches for areas under 3,500 feet elevation above sea level. and from 60 to 90 inches for those above that altitude. The depth of snow on the ridges at 6,500 to 7,000 feet elevation varies from 12 to 20 feet, as indicated by marks on standing trees. Considering the extremely wet nature of northern Idaho snows, 80 to 90 inches is probably rather under than above the actual annual precipitation at these heights. The water of precipitation is discharged slowly into the streams. The granitic rocks of the eastern range are much broken and fissured, permitting the water to sink freely and emerge as springs at lower elevations. There is a permanent snow line on the northern slopes in the central sections of the range, but the amount of snow retained through the summer is not large enough to affect materially the water supply. Many of the streams that head in the range expand into semicircular basins near their heads. Some of these basins contain small ponds; others are partially filled with great masses of slidden rock which retain large quantities of water. Owing, however, to the precipitous nature of the range, and the short distance between the summit and the lake basin, the drainage is too rapid on the whole, and but one stream of considerable size, the East Fork, heads in the range. The streams that enter the lake and river from the west are longer and carry a greater volume of water. Their heads are at greater distances from their points of discharge, and, flowing through valleys with but little slope, their currents are rather sluggish. Many of them head in large marshy or springy tracts, and in their course are frequently interrupted by large timbered flats or low swampy meadows or sphagnous bogs. These flats and bogs are important conservators and regulators

PRIEST RIVER NEAR ITS JUNCTION WITH THE PEND OREILLE.

of the water supply of the basin. The flow of water in the basin is apparently not subject to very violent fluctuations. The difference between high and low water in the lake is said to be but 5 feet. Whether the present condition of the forest in the region affects the drainage as compared with the flow of water in the past, when different conditions existed, can not be learned, as the observations extend back only seven years. I am of opinion, however, that the spring freshets are greater than formerly and the summer stage of water less.

The water in the streams and lakes is not utilized in any way at the present time. The existing agricultural interests are small, and irrigation has not been found necessary for their maintenance, nor are there within the reserve any industrial enterprises that require water power. All the larger streams that enter the lake and river from the east have volume and fall sufficient to furnish great quantities of power, a few from the west could be utilized in the same way, and the main Priest River, especially below the rapids, is capable of supplying enough for all enterprises likely to be located within the reserve for generations to come. There appears, so far, to be but one location for purposes of power on any of the streams. This is at Blue Creek, about one-third mile above its junction with Priest River. The creek here runs over a ledge of outcropping rocks, forming a series of falls and rapids with a total descent of between 30 and 40 feet.

SOIL.

The soil of the basin varies considerably with location and elevation. In the eastern half of the basin, where the underlying rock is largely composed of hard quartzose granites, the soil is very siliceous. The softer schistose formations of the western half have yielded a soil with less silica and more magnesia and alumina. The soil on the summit of the main ridges, spurs, and upper slopes is a coarse gravel or sand thinly mixed with mold derived from ages of decaying forest growth, usually but a few inches in depth and resting on a substratum of still coarser fragments of rock or bowlders. The lower slopes and bottoms of the canyons heading in the eastern range are covered with masses of bowlders and slidden rock fragments, more or less cemented together by stiff clays and overlain by thick deposits of black mold and humus, in part accumulations washed down from the heights above. The low-lying broader and less sloping valleys on the west, together with the main Priest River Valley, have a subsoil wholly made up of glacial detritus, consisting in some localities of stiff, impermeable, gray, or extremely ferruginous clays, but mostly composed of fine or coarse gravel. The depth of this subsoil is unknown. It is commonly topped off by several feet of lacustrine silt, on which rests mold and humus of varying thickness, from 3 or 4 inches to 15 or 20 inches. The marshy flats or meadows occurring in the western half of the reserve are often the result of beaver dams, constructed ages ago when the animals were plentiful and worked comparatively undisturbed. Owing to the more rapid growth and decay of vegetation on such tracts, there is a greater accumulation of mold than elsewhere, and it is also more fertile. The fertility of the soil resides largely in the superficial layer of mold and humus. When stripped of this the underlying silt deposit comes into view. While not so siliceous as the soils of the granitic half of the reserve, it contains too much silica to be classed as a prime soil for agricultural purposes. One chief drawback is its failure to retain moisture, losing it rapidly both by evaporation and by percolation. When, therefore, denuded both of its forest covering and the top layer of humus, the soil is apt to become quite sterile, owing to aridity. The soils on the small portion of the reserve that abuts on Pend Oreille River are mostly similar to those of the Priest River Basin proper. Exceptions are found on lands periodically overflowed, which are covered by a slimy subalkaline mud deposited from the waters of the river.

FOREST CONDITIONS.

The Priest River Basin is essentially a forest-covered region. There are but few tracts within its boundaries that do not now, or did not a few years ago, support a dense, magnificent forest. The areas destitute of forest from natural causes are the low marshy expanses and sphagnous bogs along certain of the water courses, and rocky crests and slides of the main divides and of their higher laterals. Of the entire land area within the reserve, I estimate that about 3.5 per cent is naturally devoid of forest. Assuming that lakes and streams of the reserve cover in the aggregate about 30,000 acres, and that the entire reserve consists of 650,000 acres, we have a trifle more than 7.9 per cent deforested through the operation of natural causes. It would be possible to reclaim about 2.5 per cent of this by sylvicultural means, leaving but 5.4 per cent permanently timberless. The distribution of the timberless areas is nearly equal for each of the two divisions of the reserve, but their respective situations are diametrically opposite, for while the timberless tracts that exist in the western half are mainly grassy marshes at low elevations, those of the eastern half are regions of bare rocky expanses along the upper slopes of the divides.

The forest growth on the reserve is composed of sixteen species of trees that are always arborescent, and seven that are either small trees or shrubs, depending on soil and altitude. (See tables, p. 244.) Eleven of the trees are gymnosperms, or cone bearers; ten are evergreens; one, the larch, deciduous leaved. Five are angiosperms; three belonging to the willow and two to the birch family. Nine belong to the species commonly utilized as lumber trees, seven being conifers, two cottonwoods. Ninety-nine per cent of the lumber trees are comprised in five species, namely, western white pine, western larch, hemlock-spruce, cedar, and yellow pine. Of these, the white pine and tamarack (the larch) form about 91 per cent of the total. The distribution of

A FOREST IN THE WHITE PINE ZONE, PRIEST RIVER FOREST RESERVE

the arborescent flora lies within three of the western forest zones, the zones (1) of the yellow pine, (2) of the white pine, and (3) of the subalpine fir.

The zone of the subalpine fir comprises, in general, the ridges and slopes above 4,800 feet elevation. It follows, however, many of the smaller streams and the northern slopes of the ridges to lower altitudes, in such cases mingling with the white-pine zone. It covers about 10 per cent of the reserve area, or about 60,000 acres in the aggregate. The best development of the zone occurs on the summits, slopes, and higher portions of the canyons of the eastern or Priest River Range. It is found likewise on many of the spurs that extend into the basin from both the eastern and the western divide. It is less prevalent on the summits and slopes of the Pend Oreille divide, and has there a greater admixture of species from the zone below. Of the total area included within the zone, 7 per cent, or about 42,000 acres, is situated in the eastern half of the reserve, and 3 per cent, or about 18,000 acres, in the western half. The difference in development of the zone between the eastern and western portions of the basin is owing, in part, to the greater height of the Priest River Range, with the consequent increase in precipitation and lowering of the mean annual temperature, and, in part, to the difference in rock formation. The granites of the eastern range, with their extensive fissuring and no definite cleavage, hold precipitation far better than the schistose rocks of the western range, which are either water-tight or else afford a more or less rapid drainage along their cleavage, depending on their angle of inclination. The characteristic trees of the zone are the subalpine fir and white-bark pine. (See tables, p. 244.) According to the direction of slope exposure, there also occur the Engelmann spruce, the red fir, the lodgepole pine, the western white pine, and the tamarack, together with the American aspen. About 98 per cent of the forest growth of the zone is composed of two species, the white-bark pine and the subalpine fir, about 28 per cent of the former and 70 per cent of the latter. (For range in sizes see table, p. 246.) This zone possesses but little economic importance. The trees that form the bulk of it are not commonly utilized, and its considerable altitudes make it inaccessible to the lumberman.

The white-pine zone is the predominant one in the reserve. It lies principally between altitudes of 2,400 and 4,800 feet above sea level, and reaches its greatest development between elevations of 2,800 and 3,500 feet. Its area is about 80 per cent of the forested portion of the reserve, or about 480,000 acres, including such tracts as are now in a state of reforestation and covered with pure, or nearly pure, growths of lodgepole pine. The principal species of trees growing within the zone are the western white pine, tamarack, cedar, Engelmann spruce, Merten hemlock, and white fir. Mixed with them are scattered individuals of the red fir, cottonwoods, birches, and semiarborescent willows. The western white pine and the tamarack are the chief components of the zone, forming about 77 per cent of the entire growth, western white pine constituting about 42 per cent and tamarack about 35 per cent. (See tables, p. 246.) The heaviest growth of the zone occurs on the level areas bordering the principal streams. The white pine is therefore more abundant in the western half of the reserve and along the Lower Priest River than elsewhere. Some of the stream bottoms in the southeast corner of the reserve, opening into the Pend Oreille Valley, have also considerable bodies of it. The region of the white pine is the most important in the reserve from an economic standpoint. It contains by far the largest quantity of commercial timber that exists on any of the growing areas.

This zone is generally easy of access, and, if the natural conditions of soil and humus are not disturbed, is capable of maintaining and of rapidly producing a heavy forest growth. The zone is remarkable for the prodigious development of its two principal components, the white pine and the tamarack, surpassing in density any other area of similar composition in the West. Two stages of growth occur in the commercially valuable bodies of this timber. They are the "old growth" and the "second growth." The former ranges in age from 250 to 400 years, the latter from 100 to 250. The old growth is found as small, scattered groves throughout the reserve, but in a large block only in the main Priest River Valley below its junction with the East Fork. It forms here a tolerably compact body of about 2,500 acres, with extensions up several of the adjacent canyons on the east amounting to about 1,000 acres more. The total area of the old growth is approximately 10,000 acres. The second growth was well developed in all portions of the reserve up to within the last thirty years. At the present time the heaviest bodies exist in the valleys of the Upper and Lower West Forks, especially in the latter. (For relative sizes of trees, see tables, p. 247.) The zone is not so well defined as that of the subalpine fir. Along its upper limits it contains more or less subalpine elements, and at its lower limits trees from the zone of the yellow pine. The only species of tree within the reserve not found in the white-pine zone is the white-bark pine.

The zone of the yellow pine occupies mostly a lower position than that of the white pine. It is not generally possible, however, to draw a well-defined line of demarcation between the upper limits of one and the lower limits of the other. The two zones overlap constantly, depending largely on soil and moisture conditions. The main components of the zone are the yellow pine, red fir, and white fir, in about the following proportions: Yellow pine, 10 per cent; red fir, 70 per cent; white fir, 15 per cent. (See table, p. 246.) The altitudinal limit of the yellow pine as a commercially valuable tree on the reserve is under 3,500 feet above sea level, while the red fir readily ascends to elevations of 4,500 feet on the slopes fronting on the south, west, and east. The area covered by this zone is about 10 per cent of the forested portions of the reserve, or about 60,000 acres. It is therefore

A FOREST OF LODGEPOLE PINE [illegible] TO [illegible] YEARS OLD, PRIEST RIVER FOREST RESERVE

equal to the area of the subalpine zone, and, as a whole, is more equally distributed between the east and west halves, about 4.7 per cent being in the former and 5.3 per cent in the latter division of the reserve. There is, however, a marked difference in the distribution of the yellow pine and the red fir, the pine predominating in the eastern half and the red fir in the western. The commercially valuable areas of yellow pine are much scattered. There are small tracts of it along the eastern shore of Lower Priest Lake, and some scattered growths facing the south and west on the rockier spurs that come into the main valley from the east below the lake. The largest bodies of it are found in the southeast quarter of the reserve, but are not continuous over any considerable area, as most of the canyons which radiate from the main valleys carry the white-pine zone in their bottoms. The tracts which are covered with commercially valuable hemlock-spruce occur all over the reserve below the upper altitudinal limits of the zone to which they belong. The largest continuous growth of the species occurs, or rather occurred, along the summits and slopes of the southern portion of the Pend Oreille divide, before the forest fires had done their work in that locality. The yellow pine is, on the whole, more difficult of access than the white pine, due to its habitat upon the rocky slopes and benches.

ASPECT OF THE FOREST.

The appearances of the growing forest are different for each of the zones, and several varying aspects occur in each subdivision; but as like conditions have produced them, they are quite uniform throughout the reserve. There are no forests of pure growth on the reserve, the nearest being the forests of the subalpine zone, and the tracts covered with lodgepole pine, within the limits of the white-pine region.

The subalpine zone presents four chief features. The first and most typical consists of a forest of medium density—300 to 400 trees to the acre. The trees are mostly straight and symmetrical. There is but little underbrush, the ground being covered with low shrubs of species of huckleberries, or with a growth of alpine sedges or junci, or, as is generally the case, with a dense sward of the common bear grass (*Xerophyllum tenax*). Litter is scanty, consisting of a few broken branches or tree tops. Humus is either wholly absent or but 2 or 3 inches in depth. Forests of this character are found on the ridges and slopes, mostly above 5,500 feet elevation, and represent the mature but still vigorous subalpine forest.

The second aspect is that of a forest of great density—1,000 to 2,000 trees to the acre. A tract of this character is usually littered with vast quantities of broken and dead trees, dead branches, and growing brush, consisting in the main of mountain alders, mountain ash (*Sorbus sambucifolia*), and Menziesia shrubs. There is sometimes a sparse growth of bear grass, but the sunlight admitted through the dense masses of trees is usually too scanty to permit the growth of many herbaceous plants. Such tracts represent the young and rapidly growing subalpine forest in the last stage of the reforesting process subsequent to complete destruction by burning. At the present time this type of forest is most prevalent on the slopes and summits of the lateral spurs with northern exposure, and in the saddles, or sags, in the main divides.

The third aspect is that of densely brush-covered areas with a thin forest—10 to 100 trees to the acre—rising from the midst of a sea of brush composed of species of alders (*Alnus alnobetula*), mountain ash (*Sorbus sambucifolia*), and especially of Menziesia and Azalea shrubs (*Menziesia ferruginea* and *Azalea albiflora*, respectively). There is a great amount of litter, consisting of large fallen trees, dry or in a state of decay. Humus is almost lacking, and the young growth, to take the place of the dead old, is scanty. Forest stands which present this phase are either in a state of decay, owing to advanced age, or are produced by forest fires occurring either early or late in summer when the litter was not sufficiently dry to flame, but underwent slow incineration, cooking the bases and roots of the trees. Tracts of this sort occur everywhere in the zone, but are more abundant on the slopes leading into the saddles of the ridges.

The last aspect is confined almost wholly to ridges having an easterly and westerly trend, and, in consequence, presenting their sloping sides directly north and south. The southern face in such situations may contain expanses of 50 to 500 acres having but scattered trees and shrubs, but covered with a dense and heavy growth of many species of mountain grasses. Such tracts are areas that once were heavily timbered, but have had their forest burned off, and, owing to direction and angle of slope causing too rapid drainage and evaporation, have been rendered too arid to permit a renewal of forest growth. The only litter on these tracts are the charred stumps of trees consumed by fire centuries ago. The northern slopes of such ridges usually bear a forest with the aspect of number two, unless, as in some cases, covered with rock slides, while the comb of the ridge has a dense, low-growing belt of young subalpine firs bent and twisted in all directions by the weight of the snow that is blown up over the southern face of the ridge.

The white-pine zone displays fewer aspects. There is usually a large amount of litter, consisting of fallen trees, that have accumulated for centuries, in various stages of decay. The undergrowth is mostly dense, consisting of young trees, the white fir and Merten hemlock predominating. In the low and wet places along the streams various species of shrubs, as alders and dogwood, form dense thickets. There is always a considerable layer of humus, varying in depth from 8 to 14 inches, composed of decaying vegetable débris. The forest is generally wet, often swampy, the humus serving as a sponge and preventing evaporation from the soil beneath. By reason of the considerable size of the trees the aspect of the forest is that of excessive density, but it

YELLOW-PINE GROWTH ABOUT 100 YEARS OLD IN THE LOWER YELLOW-PINE ZONE, PRIEST RIVER FOREST RESERVE.

is rather medium than otherwise, having from 150 to 400 trees 6 inches or more in diameter to the acre on tracts of second and old growth.

To the white pine zone belong the areas supporting a nearly pure growth of lodgepole pine. They are found throughout the reserve on the lower flats and terraces of the stream valleys. In some localities they are of considerable extent, the largest area being just below the south end of Lower Priest Lake and stretching thence nearly to the junction of the East Fork with the main Priest River. This character of forest is usually very dense, the areas containing from 800 to 2,000 or more trees to the acre. There is often a considerable amount of litter, consisting wholly of broken-down young growth. Where the forest has reached an age of 90 years and upwards there has accumulated a depth of humus ranging from 3 to 6 inches. The undergrowth is low and scattered, composed mainly of Pachystima, service berry, Holodiscus, and various species of alders and willows.

The forests of yellow pine present two phases. First, the areas where the preponderance of growth belongs to the yellow pine. This occurs on rocky slopes of low elevation facing the south or west. The forest floor is generally covered with grass or sedges that grow in dry soil. The undergrowth is at minimum density and is formed of low shrubs, such as Holodiscus, Opulaster, wild syringa, mountain ash, and the sanguineous Ceanothus. Humus is lacking or is a mere top dressing of dry pine needles and cones. There is no litter except where a fire has recently swept through.

The second phase of the forest occurs where the red fir replaces the yellow pine. This takes place whenever there exists a deeper, less rocky soil, heavier precipitation, and less rapid drainage.

The grassy slopes characteristic of the former phase of the zone are mostly lacking, and are replaced by a heavier and more extended growth of the shrubs previously enumerated. The forest growth is dense, in some localities ranging from 800 to 1,500 trees to the acre, but where such density exists the diameters of the individual tree are small. The litter is generally abundant, consisting of fallen trees, and the humus attains a depth of 3 to 5 inches.

AMOUNT OF AVAILABLE TIMBER.

By reference to the table on page 249 it will be seen that the estimated amount of merchantable timber on the reserve is 4,833,600,000 feet B. M. Less than 2,000,000,000 feet are contained in sizes suitable for saw logs. This shows that there is a vast amount of young growth. The large areas covered with this growth are due to the burnings of 120 to 150 years ago, the reforesting process just entering the fourth stage, or second growth. They bear, however, very nearly as great quantity of timber as the areas of old growth, by reason of their excessive density, but the diameters of the standing trees are relatively small. The availability of the timber depends on two conditions: first, accessibility, as determined by the topographical features of the country; second, the particular line of forestry policy adopted with regard to the amounts that may be safely cut without impairment of the strength of the forest. By strength is here meant the collective resistance offered by the living growth to the wind, which is by far the most destructive natural agent that operates in the basin.

It would require a long and close exploration of the reserve to estimate with accuracy the amount of timber available under the two conditions named, and the table of estimates prepared in this connection should only be taken as indicative of a rough average.

The following estimate of the total amount of standing merchantable timber is given:

	Feet.
Young growth	3, 141, 840, 000
Second and old growths	1, 691, 760, 000
Total	4, 833, 600, 000

The amount accessible is estimated as follows:

	Feet.
Young growth	2, 073, 614, 400
Second and old growths	1, 353, 408, 000
Total	3, 427, 022, 400

Of this the following amount may be safely cut without impairment of the forest strength:

	Feet.
Young growth	377, 020, 800
Old growth	270, 681, 600
Second growth	406, 022, 400
Total	1, 053, 724, 800

The real area of accessibility is an uncertain factor. It is one that varies constantly with the price of lumber products and of labor, the character of seasons, etc.

Practically there are no areas in the white and yellow pine zones beyond reach. It is simply a matter of profit and loss in providing means of transportation from the steep upper hillsides and narrow canyons to the flats and valleys below. The possible output may also be greatly increased by increasing the cutting in each of the tracts beyond the limit here suggested.

SOUNDNESS OF THE TIMBER.

The dominant tree in the subalpine zone, *Abies lasiocarpa*, is commonly subject to heart rot at an early period in its growth. It is rare to find trees with diameters of 10 inches and upward that do not show a ring of decay at the core. The white-bark pine, on the contrary, is commonly sound even at the most advanced age. The wood is hard and tough, resisting decay to a remarkable degree, and if the tree grew in accessible localities would be of value in cases where it forms a sizable clear trunk, as is sometimes the case. The other trees of the subalpine zone are generally free from defects, except such as are caused by external violence, as breakage by wind and snow. It may be estimated that of the total growth in this zone about 60 per cent of the trees from 6 inches in diameter at the base and upward are defective from some cause. The timber in the white-pine zone contains considerable defective portions. Aside from the damage done by forest fires, which is not taken into account now, there is a great deal of heart rot, wind shakes, and gum cracks. Most of the damage occurs in the white pine, which appears to be more subject to decay here than elsewhere in the West. The percentage of defect varies with character of soil and age of growth. It is greatest on areas of old growth and on low ground, and least in the second growth and on moderately dry soils. The percentage runs from 15 to as high as 25 per cent in the former, and from 5 to 15 per cent in the latter, all species of trees included. More than three-quarters of these amounts belong to the white pine alone. Next in frequency of defect come the cedar, Merten hemlock, and western tamarack, in the order named. The most common defects are attacks by fungi, causing either decay of the heartwood or destruction of the cambium layer in the growing trees, wind shakes, gum cracks, and breakage and splitting of the trees by the excessively violent winds or snows. Aside from the agencies of man and wind, fungi are the most destructive. The white pine and cedar are especially subject to their attacks. The weakening effect of decaying heartwood on such tall trees is to render them less capable of resisting great wind stress, and therefore more liable to development of wind shakes and gum cracks. The defects at the heart of the white pine, cedar, and tamarack do not wholly destroy their usefulness, though very materially lessening the value of the individuals so affected. In shingle making, to which purpose the larger cedars are mostly put, the decay at the core, if not too great, does not matter very much, as the central portions are usually discarded in any case, and in the white pine it is a common practice at the mill to saw around the decayed core. The defects in the tamarack are chiefly gum cracks and wind shakes, due in part to the swaying of the tall trees under wind pressure. They are produced mainly in the lower part of the trunk and are pretty sure to enlarge as time passes.

The defects in the yellow-pine zone are mostly gum cracks and crooked and deformed trees. Owing to the open character of the forest in many places the wind has a free sweep. The damage is confined chiefly to the red fir, aggregating about 5 per cent, against less than 2 per cent in the yellow pine.

MEANS OF TRANSPORTATION OF LUMBER.

The only method available at the present time to transport lumber out of the reserve is by driving on Priest River to its junction with the Pend Oreille, at which point the Great Northern Railway is reached.

The Lower Priest Lake is navigable for steamers of any draft; the upper, owing to shallowness in the Thorofare, only for boats of light draft. Above the upper lake the river can be utilized for driving for several miles by removing the snags that block it here and there. Not many of the side streams can be used for this purpose without expensive improvements in their beds. Some, notably those that enter from the east, are full of big bowlders and interrupted by series of falls, while those from the west either have a sluggish current which meanders through marshy expanses or are much obstructed by windfalls and in some cases by rocky ledges. The valleys on the west half of the reserve, however, with their easy slopes, offer good opportunities for the construction of logging roads to bring their timber to the main river. The water in the river usually maintains until the 1st of August a sufficient depth to permit driving, but by building a dam across the point where it leaves the lake, an undertaking easily accomplished, a sufficient volume of water could be held back in the lake to float logs down Priest River at any time. The area in the southeast corner of the reserve fronting on Pend Oreille Valley is adjacent to the Great Northern Railway, and the timbered valleys are easy of access from that side by means of logging roads. The most feasible way to utilize the water in the tributary streams for logging purposes would be to construct flumes and turn the streams into them.

LOCAL DEMAND FOR LUMBER.

There is scarcely any local demand. Small quantities of timber are used locally for fencing, building material, shingles, logs, etc., but the total consumption for these purposes is insignificant. There are no sawmills in the reserve. The nearest point at which a sawmill is located is Sand Point, at the northwest corner of Lake Pend Oreille. If the lumber on the reserve could be obtained without trespass and its attendant difficulties, it is pretty certain that sawmills would soon be established near the outlet of Priest River, in the Pend Oreille Valley, for the manufacture of lumber and shingles. The quantity of tie timber on the reserve is immense, and railroad ties are nearly always in demand at good prices to the producer.

TIMBER CUTTING.

The cutting done in the past on the area now included in the reserve was chiefly in connection with the construction of the Great Northern Railway some years ago. The timber taken was almost wholly tie timber and piling, consisting of young trees 12 to 20 inches in diameter, of cedar, hemlock, spruce, and tamarack. Most of the cutting was adjacent to the line of the road where it passes through the southeast corner of the reserve. Along a distance of about 6 miles the tie timber on the north side of the road was cut nearly 90 per cent on lands within one-half a mile, and from 35 to 50 per cent on lands a mile, from the line of road. Since the road was completed small quantities of ties have been cut on lands adjacent to the main Priest River from the outlet into the Pend Oreille to a point about 12 miles above. The cutting done at the present time consists of clearings, wood for fuel, building, and fencing. During the last summer (1898) parties were cutting the white pine on Lower West Fork and floating it to the Great Northern Railway crossing of Priest River, whence it was shipped. Ostensibly the cutting was done with a view of furnishing samples of western white pine to lumbermen in the East. The trees were felled on the Lower West Fork and along the main Priest River, squared in the forest, and floated down the river to a boom at Priest River Station.

PRESENT CONDITION OF THE FOREST—FIRES.

In the foregoing pages the forest conditions have been detailed with reference to the state of the growing, more or less commercially valuable timber. It now remains to examine the extent of the actual area covered with a forest of this character. The area capable of growing a forest, and that did grow one not very many years back, is about 90 per cent, or 600,000 acres. Of this amount about 60,000 acres belong to the subalpine zone, leaving 540,000 acres as the area capable of producing merchantable timber. The density of the present forest varies considerably. On small tracts in the white-pine zone it may run as high as 120,000 feet per acre, including all timber above 8 inches diameter at the butt, and it may dwindle to 2,000 feet or less, as in some localities in the yellow-pine districts. Had there been no fires in this reserve, 30,000 feet per acre might be safely assumed as a fair average, including all kinds of merchantable timber above 8 inches basal diameter. Given an area of 540,000 acres, we should have a total of 16,200 million feet. But the entire amount on the reserve should be greater. In the lower portion of the subalpine zone there are many tracts containing appreciable quantities of white pine, tamarack, cedar, and red fir. There are probably 10,000 acres of this that would yield an average of 3,000 feet per acre, adding 30,000,000 feet to the figures above. We should have then as a total 16,230 million feet as the amount of standing timber on the reserve. These figures are confidently believed to be under rather than above the true value. Large areas where the forest is untouched have an extremely dense growth, and the long slopes of the ridges and spurs increase the actual acreage considerably over the horizontal measurements, which are the only ones considered here. By reference to the tables of standing timber on the reserve, it will be seen that the estimated amounts standing at the present time are as follows:

	Feet.
Saw timber	1,903,600,000
Ties, at 20 feet per tie	2,720,000,000
Telegraph poles, at 100 feet per pole	210,000,000
Total	4,833,600,000

This leaves a total of 11,396 million feet unaccounted for. This immense quantity of timber, of which the total cutting for all purposes, clearings, etc., does not exceed 20,000,000 feet, and is doubtless much below this figure, has been burned during the last thirty years—burned and wasted to absolutely no purpose. The estimates made on this point while examining the forest were as follows:

	Feet.
Saw timber	4,488,800,000
Tie timber, at 20 feet per tie	4,900,000,000
Telegraph poles, at 100 feet per pole	600,000,000
	9,988,800,000
Add for clearings, cuttings, etc	20,000,000
	10,008,800,000

This leaves 1,387 million feet unaccounted for. We will assume, what is doubtless true, that the burnt areas were not necessarily as heavily timbered in all their parts as are the growing ones now. We can not, of course, be certain on this point. Our estimates must be based on the character of the forest that adjoins the burnt tracts, and on the number and size of the partially consumed stumps and other wreckage.

To keep our estimates low we will therefore ignore the balance of 1,387,600,000 feet, although this amount could, with safety, enter into the estimate as representing other species than those furnishing merchantable timber. The amount could even be increased. Thousands of acres of the subalpine forest have been totally destroyed, leaving not a tree of the original growth alive. It is true that the trees which form the bulk of its growth have no market value at the sawmill, but for local use, such as mining timbers in small workings situated in the high elevations, where no other species are obtainable, the subalpine fir and white-bark pine are vastly superior to the lodgepole pine, often used elsewhere for this purpose. We should not exaggerate if there were added another billion feet to our fire losses from that source.

This timber has not all been literally consumed by fire. The forest fires in this region seldom burn the timber completely. They kill more by cooking the roots and the lower portions of the trunks than they consume. The severe wind storms of the fall and winter throw down great quantities of both dead and living trees, soon completely denuding the burnt-over area. Of the 540,000 acres below the subalpine zone, 280,000 acres average now less than 12,000 feet per acre of all sizes, an insignificant amount for a region with normally so dense a forest growth as the Priest River Basin, while 260,000 acres have less than 7,300 feet per acre.

These averages, however, do not show the real state of the matter. Of the 540,000 acres that make up the white-pine and yellow-pine zones, there are not 80,000 acres that are not seared by fire. Excepting a small area of about 1,600 acres along the Lower West Fork, there is no body of timber of 1,000 acres, or even 500 acres, extent not scorched

BURNT AREAS NEAR REEDER CREEK, PRIEST RIVER FOREST RESERVE, DEAD TIMBER THROWN DOWN BY WIND.

by fire. In the two lower zones there are over 200,000 acres on which the destruction is practically complete. In the subalpine zone at least 40,000 acres of the 60,000 have been more or less injured by fires.

One meets with burnt areas everywhere—in the old growth, in the second growth, in the young growth, and where the seedlings that are beginning to cover the deforested areas have just commenced to obtain a fair hold. The burnt tracts are in large blocks, thousands of acres in extent, and in small patches of 15 to 50 acres which extend in all directions through the forest, which at a distance is apparently green; sometimes they are in broad swaths, sometimes in narrow, tortuous windings just sufficient to open a lane for the destructive high winds to tear the living forest down. The burnt areas are scattered all over the reserve, but the largest amount of damage lies within the zone of the white pine, by reason of its greater extent and peculiar susceptibility to destructive fires. The most extensive plats of burnt forest are found in the northern and western portions of the reserve, corresponding exactly to the regions that are supposed to contain the largest areas of mineral-bearing country.

Forest fires occurred in the Priest River Basin ages ago. About one hundred and fifty years ago the area surrounding the lower and, in part, the upper lake was burned over to the extent of more than 60 per cent. Later, a large tract south of the lower lake shared the same fate. This is proved by the great quantities of young growth, less than 100 years old, that exist in many places with very old trees in their midst. After these fires came an interval of sixty to seventy years with but few burns, involving only small areas. The beginning of the fires of modern times in the basin dates back about thirty years. They owe their origin mainly to the universally wanton disregard for the value of the growing forest in general, and for public property of this kind in particular, which is so unfortunately prevalent in the West. Many of the fires have originated within the present boundaries of the reserve. Those of late years have all started there. Others have come in by way of the Pend Oreille Valley, from the Metaline mining districts, and from other real or supposedly mineral districts. Still others have originated east of the Pend Oreille divide near Lake Pend Oreille, and between it and the Kootenai River, thence spreading westward into the basin. The areas adjoining the reserve are indeed more devastated by fires than those contained within it. Prospectors, hunters, and trappers have kindled most of the fires, and still continue to do this. Large areas in the main Priest River Valley, in the dense old and second growths, have been burned by the various supervisors in charge of the wagon road from Priest River Station to the south end of Lower Priest Lake. They set fire to the heaped-up brush along the side of the road, and the fire spreads thence into the adjoining timber without check or hindrance. This is done as an expeditious and inexpensive way of improving a wagon road.

The pecuniary loss to the Government, and to the community in whose neighborhood the burnt areas are situated, is immense. The marvelous apathy of public sentiment at the destruction of such important sources of wealth as the Western forests can only be accounted for on the supposition that the enormous interests involved and the vast losses that the forest fires cause are never realized. It is true that the forest growth in the Priest River Basin has been exceptionally heavy, and that therefore the losses elsewhere, on areas of like extent, have not been so great, but they are nevertheless of sufficient magnitude in any locality to demand a speedy and decided change in public sentiment.

Our estimates place the fire loss in forest material throughout the Priest River Basin for the last thirty years at 4,488 million feet of saw logs, 245,000,000 railroad cross-ties, and 6,000,000 telegraph poles. These have a monetary value in the forest about as follows:

4,488,800,000 feet of logs, at 50 cents per thousand feet	$2,244,400
245,000,000 ties, at 2 cents per tie	4,900,000
6,000,000 telegraph poles, at 5 cents per pole	300,000
Value of young growth during thirty years	1,500,000
	8,944,400
Less depreciation by windfalls, etc	447,220
Net loss	8,497,180

These figures are based on the low and customary stumpage that obtains now. The stumpage loss, however, is in fact but a small percentage of the real loss. The community that has in its midst, or adjacent to it, a large area of mature forest in a state of good preservation has a mine of wealth, if not at once in the not far-distant future. The working and business interests of such a community are the chief losers in the destruction of the neighboring forest. It has in the past been customary to compute the loss from forest fires on the basis of stumpage, but any account that does not include the losses to the working and business interests of the community most nearly interested fails to gage the matter properly.

To bring the products of the forest to the hands of the consumer requires a large amount of labor of various sorts. Large sums of money are brought in and set loose in different business channels. Taking this into account, let the computation be based on the value of the product when ready for consumption at the mill or railroad track.

4,188,800,000 feet lumber, at $10 per thousand	$44,888,000
215,000,000 railroad ties, at 20 cents per tie	49,000,000
6,000,000 telegraph poles, at 25 cents per pole	1,500,000
Value of young growth during thirty years	15,000,000
	110,388,000
Less depreciation during thirty years	4,447,220
Net loss	105,940,780

BURNT AREAS NEAR REEDER CREEK, PRIEST RIVER FOREST RESERVE. DEAD TIMBER THROWN DOWN BY WIND.

This amount could readily be further increased. There is the added loss to the sections obliged to import lumber from long distances, owing to the supply near home having been burned up. Then the value of the young growth is placed low—less than 90 cents per acre per year—and no account is taken of the utter destruction of the humus of the forest floor which usually ensues. The humus is absolutely necessary to a first-class growth of such species as the western white pine, the tamarack, the cedar, and the hemlocks; and one of the most serious results of forest fires is the destruction of this vegetable layer. On areas where the burning of it has been complete, it may require fully one hundred years before a sufficient depth has accumulated to make possible the growth of the species enumerated. It rarely requires less than twenty years, unless the situation is exceptionally favorable as regards moisture.

When it is considered that forest fires can easily be kept in check, the destruction they bring seems all the more deplorable. All that is required is an active, healthy public demand, in the localities, counties, or States where they occur, that they must cease, and a proper enforcement of the laws bearing on the subject. But so long as people living in the forested districts believe in and applaud the sentiments frequently heard uttered on the reserve, so long fires will rage, unless stopped by Government interference. It has been a common occurrence to hear such remarks as, "If the Government intends to guard and preserve the timber from fires and prevent unlimited cutting, we will try to burn up what is left as soon as possible;" or, "Since the reserve has been set aside every prospector carries an extra box of matches along to start forest fires with." These sayings were not made in a spirit of bravado, but with the conviction that the course outlined was the proper one to pursue to show their disapproval of Government interference in what they have heretofore considered their rights, namely, to cut, slash, or burn, as convenience or fancy might dictate. Such sentiments are common almost everywhere in the forested region in the West among those classes whose occupations bring them into closest touch with the living forest. The other classes care but little one way or another. It is deplorable that such should be the case.

EFFECT OF FIRES ON REPRODUCTION.

The after effects of fires depend on the season of the year in which they occur, the supply of moisture to the portion, slope, or terrace burned over, and, last and most important in the white-pine region, the more or less complete incineration of the humus, as this layer of mold is indispensable to the growth of a commercially valuable white-pine forest. By humus is here meant the topmost layer of the forest floor, composed of decaying pine needles, wood, and vegetable débris of all sorts. It is always in an active stage of decay, accelerated by its ability to retain moisture and by the vast number of fungi that send their mycelia through it in all directions. It is not a fertile bed for grasses or small herbaceous plants, but for certain forest trees it is indispensable. None of the conifers that normally belong to the white-pine zone possess a taproot. They penetrate into the layer of soil but a few feet, sending out their roots widely just under the humus. Forest fires and their after effects vary more or less in different regions. The account here given of the fires within the Priest River Reserve are therefore not to be considered as furnishing a standard applicable to other sections.

Forest fires prevail at three seasons of the year: Spring, from late April to June; summer, from the middle of July to the beginning of September; and fall, from the beginning of September to the middle of October. Conflagrations during the first two seasons are more common; during the latter they are comparatively rare and are mostly survivals of the summer fires not quenched by the fall rains. The spring fires burn slowly and flame but little; the humus incinerates slowly, and many patches are thoroughly drenched with contained moisture and do not burn; the subalpine areas are covered with snow, or at least are extremely wet, and fires can not readily spread beyond the lower zones, therefore not across ridges high enough to touch the upper zones. The summer fires find the humus, if not thoroughly dry, yet sufficiently dry to permit rapid incineration, and conifers are ready to shed their leaves, which now contain little moisture but sufficient terebinthine matter to flame furiously, communicating the fire to whatever dead branches exist in the trees. The summer fires therefore flame considerably, and when fanned by a strong wind, which frequently happens in this basin, open to the south, burn furiously. Fires at this season are most destructive, and encounter no particular check to their progress. The fall fires resemble those that occur in the spring, but are even less extensive.

Fires in the subalpine zone occur in the summer. If very early they resemble the spring fires in the zones below. Occurring on the high ridges, the wind has a better chance to accelerate their spread and create a hotter fire, which burns the humus completely.

Reforestation in this zone proceeds more or less rapidly according to the intensity of the fire and the slope exposure. In general it is extremely slow, but usually the same species that occupied the ground originally come in again as the predominant forest growth. Sometimes in the lower edge of the zone a preponderance of the lodgepole pine forms the growth, but usually it is either the subalpine fir or white-bark pine, or both, that come in on the burnt tracts. On areas where the fires ran in the early summer or fall, or on humid northern slopes, where they occurred during the summer and did not wholly destroy the humus, although cooking, killing, and partially burning the forest, there come in, as the first attempt at reforesting, dense masses of Menziesia shrubs with a liberal admixture of alders and mountain ash. These shrubs exist everywhere throughout the subalpine zone in certain proportions at all times. Their roots extend far below the humus into

FIRE STARTED BY ROAD SUPERVISOR IN JULY, 1897, IN THE WHITE-PINE TIMBER 1 MILE BELOW THE JUNCTION OF THE EAST FORK AND PRIEST RIVER

the underlying rocky soil, and they are not exterminated by a slow spring or fall fire. After the forest is burned they often attain an excessive development. Their density is such that they effectually choke out all seedlings of the subalpine forest trees for long periods of time. Eventually, however, the original sylva again covers the ground and the shrubs die out. The new forest develops great compactness, especially on slopes well provided with seepage; the trees are set close and are too slender and tall to resist effectually the force of wind and snow. In consequence large numbers are uprooted annually, nevertheless, the forest regains its normal open character very slowly. On slopes that have been ravaged by summer fires where the wind has assisted to fan the flames the destruction is often complete to the entire extermination of the roots of the shrubs. The first vegetation to appear after such a fire comes in the form of small herbaceous plants, prominent and characteristic among them being *Epilobium angustifolium*. The shrubby growth comes more slowly, fifteen to twenty years usually passing before the ground is fairly covered with it. After that reforestation proceeds as on the burnt areas of the early summer and fall. When the exposure of the clean-burnt slope is toward the south the primary effect is sterility. The impact of wind and rain is sure to carry considerable of the loose soil of the denuded slope into the canyons below, leaving it bare and rocky. If, however, sufficient soil is left, various species of alpine grasses and sedges obtain a footing. Later the bear grass supplants the grassy growth, and in its turn is crowded out by dense masses of the vellum-leaved Ceanothus (*Ceanothus velutinus*) or the thin-leaved huckleberry (*Vaccinium membranaceum*), which finally prepare the soil for a forest growth of the original species, more or less mixed with the lodgepole pine. The time required for these changes to take place is not known, but must be centuries.

Fires in the white-pine zone are more widespread and destructive than elsewhere. The humus and litter are much greater and the trees more susceptible to the killing effects of the heat. Most of the destruction is wrought by the slow incineration of the humus, less destruction by the flaming process. Hundreds of thousands of trees were seen on the reserve that presented no other evidence of having been subjected to fire than that the leaves were turned red. There had been no flaming, nothing but the slow cooking of the roots, which, however, killed as surely as the flames could have done. The wind has less sweep in the white-pine forest than on the subalpine slopes; therefore it is rare to find an area burned clean by the forest fire. After a fire the wind soon throws down the dead trees, and in a few years, when the mass is dead and dry, a second fire thoroughly cleans up the accumulated wreckage. The phases exhibited by the reforesting process in the white-pine zone are normally five, up to the time that the forest again begins to assume the appearance characteristic of the old growth, but sometimes one of these phases is lacking. The time required for reforesting is exceedingly uncertain, and the bulk of the species of trees that at first appears are almost invariably others than the white pine. The factor that determines the length of time that must intervene between a burning and a reforesting with the original species is moisture supply. A burnt-over valley terrace exhibits best the different aspects of the process. Let us suppose that it is a case where the dead trees have been thrown down by wind and the débris cleaned up by a second fire. The first effect is sterility, brought on in part by excessive evaporation, producing aridity, and doubtless in part by chemical changes in the top layer of the soil, for it is a notable fact that the iron in the soil, previously existing as sulphurets, is desulphurized and oxidized, coloring the soil shades of red and brown. On this sterile surface mosses begin to grow, *Polytrichum juniperinum*, *Funaria hygrometrica* and *Leptobryum pyriformum* being the most common. Gradually herbaceous plants come in and a top layer of mold is formed, representing the first stage. The second commences when shrubs begin to obtain a foothold. In dry situations, like the valley terraces in the Priest River Basin, the principal shrubs are *Ceanothus velutinus*, *C. sanguineus*, *Salix flavescens*, strictly a bush, *Populus tremuloides*, and *Amelanchier alnifolia*, also shrubby. These species add to the top layer of mold one in which decaying leaves constitute the principal part, not deep but sufficiently retentive of moisture to serve as a seed bed for the conifer that comes in at the third stage, the lodgepole pine. It comes in with extreme density, soon driving out nearly all other vegetation, herbaceous and shrubby. It may persist in that aspect for twenty-five to thirty-five years, but is gradually thinned out by natural processes and the forest floor begins to be covered with a sward of sedge, usually *Carex geyeri*, and a thin growth of shrubs, such as *Pachystima myrsinites*, *Vaccinium cæspitosum*, *Holodiscus discolor*, and *Opulaster malvaceus*. This is the humus-forming period, which may persist for more than a hundred years. As the humus accumulates the fourth stage of reforesting begins with species of the original forest again occupying the area, but the restoration of the ancient balance between the species is a very slow process. The fifth process is simply the growth of the young trees as they progress toward the second and old growths.

When the white pine is burned on a tract of low-lying land supplied with plenty of moisture, and the trees are thrown down, they often remain as they fall until they decay. The logs do not always dry out sufficiently to burn the second time, or they burn but partially. If the humus is burned entirely out to the underlying soil, shrubs, willows, alders, and the like are the first to put in an appearance. As the fallen logs decay a humus is formed that serves as a germinating bed for seeds of the Merten hemlock and the cedar, which come in in immense numbers and soon cover the ground with a compact mass of seedlings. The Merten hemlock, obtaining a hold on the soil in such localities, often persists for ages to the almost complete exclusion of the white pine and tamarack. Where the humus is not completely wiped out,

BURNT WHITE PINE FOREST, PRIEST RIVER FOREST RESERVE, DESTRUCTION TOTAL

the white pine, tamarack, and white fir usually come in from the first, mixed to some extent with alders and willows.

The yellow-pine zone has little humus—often none at all. Fires in these areas burn rapidly, and always with a flame. The grass that covers the forest floor is the chief agency in spreading the conflagrations. The fires occur in spring, summer, and early autumn, especially in late summer when the grass is dry. The destruction is greater where the red fir prevails than where the yellow pine is the principal species. The yellow pine resists the fire better than any other forest tree in this region, while the red fir is readily killed. The after effects of the fires here also depend on the moisture supply. Both the yellow pine and the red fir will germinate without the humus layer, provided there is sufficient seepage under the soil. Seeds of the yellow pine will germinate if there be but a moderately grassy forest floor for their reception. Where the yellow pine grows the forest is open and the ground supports a grassy growth. The fire runs rapidly, but does not kill out the grass, which comes up again in the fall of the same year or the following spring. The fires, however, destroy the year's seedling plants, thus preventing reproduction, and weaken the old trees by development of gum cracks and barkless pitch streaks that furnish an entrance for subsequent fires to the center of the tree. Where red fir prevails in the zone there is a heavier growth of timber and brush, with some humus. The fires often sweep such areas entirely clean of living timber. If there is no seepage near the surface the soil is rendered arid, as in the white-pine terraces, and goes through nearly the same course of reforesting, except that in place of the lodgepole pine white fir often comes in. Where there is an abundance of seepage, as on the humid slopes of the spurs, the red fir may come in as the first tree in the reforesting process after a short course of willow and Ceanothus growth.

It may be well to summarize briefly the conclusions reached. The effect of fires in the subalpine zone is to cause permanent deforested tracts on the southern slopes above water level:[1] below this, when exposure of slope is toward the west, north, or east, brush-covered ridges for an indefinite period, reforesting slowly, but with preponderance from the first of the species that composed the original growth.

The after effects of fires in the white-pine zone are decided sterility of the soil on valley terraces, coupled with aridity due to excessive evaporation; in low places, and on north, east, and west slopes, densely brush-covered tracts. Reforesting proceeds slowly on lands of the former character, but more rapidly on the latter, provided the humus is not wholly destroyed. Lodgepole pine is usually the first tree in the reforesting process on the bench lands; cedar, Merten hemlock, and Engelmann spruce on the lowlands and on humid slopes; on south slopes,

[1] Water level is the line on any given slope where the seepage from the crest above first comes to the surface. It varies with changes in angle of slope, dip, and strike of the strata, fissuring of the rock formation, etc.

lodgepole pine and red fir. The approximate time required to reestablish the white-pine forest through natural processes is from eighty to one hundred and fifty years on bench lands; twenty to eighty years on lowlands and north, east, and west slopes of mountains; and apparently centuries, in some cases, on south slopes. Approximately sixty to one hundred and twenty years is required after reestablishment of the forest before it will supply merchantable timber. The total time required, under the most favorable circumstances, for the white-pine forest to furnish merchantable timber after destruction by fire is one hundred and sixty to two hundred and seventy years on bench lands and terraces, eighty to two hundred years on lowlands and humid slopes of the elevations, and several centuries on the dry southern slopes.

The results from fire in the yellow-pine zone are: Where the yellow pine predominates, entire cessation of reproduction by the repeated burning of the seedlings and very young trees, slow but certain destruction of the large growing timber, and enlargement of the grass tracts, which eventually become covered with brush growth; where the red fir is the prevailing tree, excessively dense development of brush on the burnt-over land. Reforesting in the yellow-pine districts begins as soon as fires cease, with yellow pine, red fir, and lodgepole pine; and in the red fir districts, with red fir and white fir on the drier tracts and lodgepole pine on the more humid. The brush period lasts from fifteen to fifty years before the original type of forest is reestablished, but where lodgepole pine growth has become firmly fixed the time is indefinite.

AGRICULTURAL LAND.

The Priest River Reserve is a forest region. Its natural peculiarities are such that it can never become an agricultural section, and all efforts to make it such should be discontinued. Its chief value lies in the immense forest growth it is capable of maintaining, and in whatever mineral deposits time may disclose.

The agricultural lands amount to about 9,990 acres, distributed as follows:

	Acres.
East half of reserve	1,850
West half of reserve	6,940
Pend Oreille Valley	1,200
Total	9,990

Situated, as to localities, as stated in table on pages 251–252.

These lands consist of tracts covered with coarse sedges or grass; sphagnous bogs capable of being reclaimed; alder and willow swamps too wet for forest growth; and, in the valley of Pend Oreille River, of grass lands subject to overflow, and of cleared lands on the benches adjacent to the streams. The agricultural lands within the reserve are

DESTRUCTION OF A MIXED FOREST, PRIEST RIVER FOREST RESERVE

found adjoining the streams. They are nearly always wet and swampy, but may be reclaimed by ditching. The bulk of these lands is situated in the western half of the reserve, where the rock formation is softer and in consequence the valleys are broader and more level. Some tracts are clear of brush; others require removal of the mass of willows and alders that covers them. The clearing of the latter class is not difficult and only moderately expensive.

All of the partially clear or grassy tracts are held by settlers, as are some of the alder and willow swamps. The natural meadows are utilized for hay production, the sedges and grass furnishing a sort of coarse hay. In a few cases small patches of the boggy meadow land have been ditched. In such cases crops of oats, potatoes, and common garden vegetables have been raised. Along the Lower West Fork a few acres of the natural meadows have been seeded to timothy. Nearly all these lands are subject to frost at any time during the growing season. Crops of potatoes or garden vegetables are therefore never certain. There is no market for farm products within the reserve. Were such articles produced in greater quantities than the home demand required they could not be shipped. There is no cheap transportation available to the railway, and if there were the producer would come into competition with like articles from other sections where they can be grown much cheaper.

The agricultural lands are separated by blocks of green or burnt forests. If any attempt at segregation is made, they will have to be separated—each small parcel by itself—in order to avoid cutting out the intervening areas of timber from the reserve.

The lands in the Pend Oreille Valley are situated in the southeast corner of the reserve. Some consist of low flats near the river and are periodically inundated, others are clearings made in the yellow-pine timber on the bench lands. These lands are far more valuable for agriculture than those in the Priest River Basin, and being nearly in a body, can readily be segregated.

The actual values of all agricultural improvements in the reserve to date are insignificant. There are many squatter's claims, but only a minimum of cultivation has been done on any of these. There is not a single holding that produces nearly enough for the support of even a small family. Agricultural settlements date back seven years, but the total of all lands in the basin brought under the plow since that time does not exceed 70 acres. Of this, perhaps 30 acres represent brush clearings, 20 acres ditched and drained meadows and bogs, and 15 acres clearings on bench lands burned off by forest fires.

Agricultural improvements on the lands in the Pend Oreille Valley are of a more substantial character. Between 150 and 200 acres are under the plow there. In the heavy timber south of Lower Priest Lake considerable land has been surveyed and subdivided, especially in township 57. There is here scarcely a quarter section, on any even-numbered section, carrying a good body of white pine that has not a squatter's claim on it, ostensibly for agricultural purposes; yet it is a positive fact that after seven years of settlement there is not in the basin a total of 5 acres cleared from the living white-pine forest.

Such claims at the present time consist simply of a log cabin of the rudest kind surrounded by a "clearing," which means a more or less completely burnt area involving the destruction of 1,000,000 to 4,000,000 feet of merchantable timber. These burnings were made with the purpose in view of establishing a lawful holding with habitation and improvements. The parties claiming these tracts live on them but a short time during the year, there being absolutely no way to gain a livelihood from the land with its present "improvements."

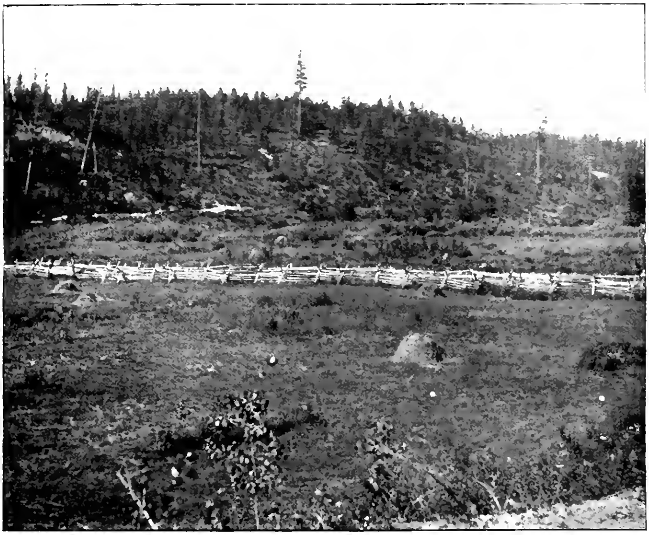
The boggy meadows and brush-covered tracts along the streams have here been considered as agricultural lands. That has been done for the reason that under proper supervision and rules agricultural operations on such lands need not necessarily infringe on the forest. It would be an entirely practical matter, however, to drain these lands at small expense, when they would soon become covered with a dense forest growth. No sheep are pastured in the reserve. Several hundred head of stock belonging to settlers living south of the lower lake range through the white-pine forest, but they do no material damage.

MINERAL RESOURCES.

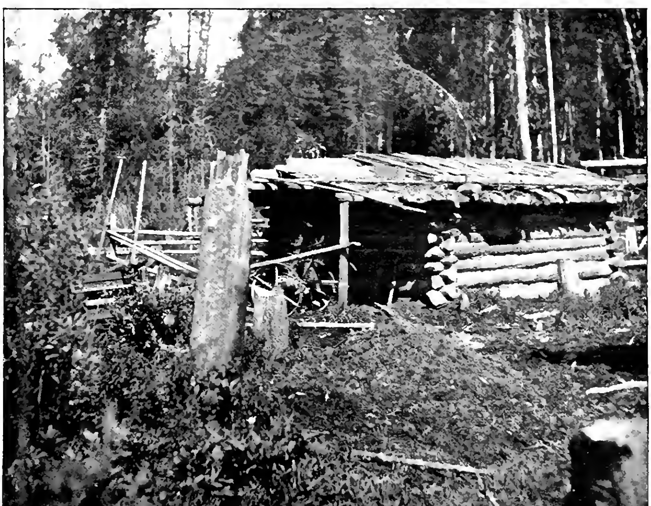
At the present time there are known to exist three mineral-bearing belts, one in the region above the upper lake, one in the central portion, and one midway between the lower lake and the south line of the reserve. Two of these belts have their long diameter easterly and westerly, and very likely stretch entirely across the reserve, while the northern one lies in a northerly and southerly direction. A great many quartz claims have been located in the mineral-bearing zones. There are none sufficiently developed as yet to prove the region a commercially profitable one in the valuable metallic minerals. It is well within the range of possibility that profitable discoveries will eventually be made in this direction.

CONCLUSIONS.

The Priest River Reserve is admirably situated for sylviculture. It needs no experiments in this direction, but merely immunity from forest fires and encroachments, ostensibly for agricultural purposes, but in reality for purposes of rapine on the merchantable forest. If protected, nature will do the reforesting. It is a demonstrable fact that unless active measures are taken for policing the reserve the present timber will soon share the fate of the other portions of the once magnificent forest. Mere reserve lines will have no effect whatever in



A. SETTLEMENT ON A NATURAL MEADOW AT JUNCTION OF EAST FORK AND PRIEST RIVER



B. SQUATTER'S HUT NEAR REEDER CREEK

preventing the destruction so long as public sentiment regarding forest preservation remains indifferent. The forest-fire evil is gigantic and appalling. If not checked, within twenty-five years there will be no accessible forests to furnish lumber products between the Rocky Mountains and the Cascades except such tracts as are under private ownership. Up to the present time the public has not suffered any particular inconvenience from the fires, but signs are rapidly multiplying that a pinch is beginning to be felt in the home timber supply. If the next ten years sees as large a percentage of burnt-over tracts as the last decade, the pinch will become decidedly painful. To combat the evil heroic measures are necessary. A condition confronts us that is not a mere distant shadow, but a stern present reality. To compromise it is to stultify ourselves. It will never cease so long as there is an acre of public forest to burn unless we firmly put an end to the evil and accomplish by coercive measures what an appeal to logic has failed to produce. The Priest River Reserve as a fire-swept region is no worse devastated than many other regions in Idaho and Washington. There are, however, in some other places compensation, small as it is, in the fact that portions of the denuded tracts are utilized for agricultural purposes. In this reserve, on the contrary, for the tens of thousands of acres burned over and the millions of dollars' worth of timber destroyed there is absolutely no gain to show. If it is intended to make a permanent reserve of the Priest River Basin, agricultural settlements should be rigorously confined to the parcels of land now naturally devoid of timber. I do not consider the burnt tracts as coming under this category. The denuded areas are still to all intents and purposes timber lands, requiring only sufficient time for reforesting. It would be better to exclude agricultural operations altogether from the reserve. Failing in this, no claim should be permitted to extend into the forest, even if it became necessary to break up the legal subdivisions into fractional parts. Existing squatters' claims on the timbered lands in the reserve should be ignored as regards any acquired "rights."

To prevent further destruction, the reserve should be policed. There are no tracts of equal extent in this region that can be guarded so easily and with so little expense. The past burnings have nearly surrounded it on three sides with denuded areas, which for years to come will act as natural ramparts. The danger lies from within and from along the south line. To guard it effectually, a patrol of six men from the 1st of April to the 15th of October, during the first year, furnished with at least twelve horses and the necessary equipments, would be required. Two stations should be provided for the patrol, located on the natural meadows of the reserve, so as to furnish the necessary pasturage and hay for the animals. Buildings suitable for quarters should be erected, for which the adjacent forest would furnish the material. There should be one station just above the junction of the East Fork and main Priest River, and the other on Reeder Creek, about 4 miles west from the lake shore. During the summer the patrol, in conjunction with police duties, should build trails to connect the stations and the different portions of the reserve. The burnt areas, with their huge masses of débris, make traveling without a trail slow, and in many places impossible. Trails should be built as follows: One from the south end of the lower lake along the lake shore to the north end of the reserve, following the valley of the Upper Priest River to its head; one from the point where the present wagon road crosses Blue Creek to the summit of Priest River Range, along this creek or on adjoining slopes; one up the East Fork to the summit of the range; one up Bear Creek, and one up Caribou Creek, both to the summit of the range; and, on the west side, a trail from the south line of the reserve, on the west bank of the river, turning up lower West Fork and following it to its head, thence along the Pend Oreille divide to the north end of the reserve, and turning southeasterly down Gold Creek to its junction with Upper Priest River, thence along the west side of the lake and river to a point opposite the junction of East Fork and Priest River, which should there be crossed. From this trail side trails should be run as necessity may demand.

This system of trails, with the roads already existing, would render all the vulnerable portions of the reserve easy of access and capable of being thoroughly patrolled. After the first construction of these trails, three men with the necessary horses would be sufficient to police efficiently the entire area embraced in the reserve as at present limited.

TABLES.

LIST OF SPECIES.

Species of forest trees.

I.—ALWAYS ARBORESCENT.

Pinus albicaulis	White-bark pine.
P. murrayana	Lodgepole pine.
P. ponderosa	Yellow pine.
P. monticola	Western white pine.
Abies grandis	White fir.
A. lasiocarpa	Subalpine or balsam fir.
Tsuga mertensiana	Merten hemlock.
Thuya plicata	Cedar.
Pseudotsuga taxifolia	Hemlock-spruce, red fir, etc.
Picea engelmanni	Engelmann spruce.
Larix occidentalis	Western tamarack.
Betula occidentalis	Western birch.
B. papyracea	Paper or canoe birch.
Populus tremuloides	Aspen.
P. balsamifera	Balm of Gilead.
P. trichocarpa	Cottonwood.

SQUATTER'S CLAIM IN WHITE PINE TIMBER SHOWING USUAL IMPROVEMENTS ON THIS CLASS OF CLAIMS

SQUATTER'S CLAIM IN WHITE PINE TIMBER SHOWING USUAL IMPROVEMENTS ON THIS CLASS OF CLAIMS

II.—VARYING FROM SHRUBS TO TREES.

Amelanchier alnifolia	Service berry.
Salix nuttallii	Nuttall willow.
S. lasiandra	Willow.
Acer glabrum	Maple.
Prunus douglasii	Cherry.
Juniperus virginiana	Red cedar.
Taxus brevifolia	Yew.

Species of trees in the Priest River Reserve utilized as lumber trees.

Pinus ponderosa	Yellow pine.
P. monticola	Western white pine.
Tsuga mertensiana	Merten hemlock.
Thuya plicata	Cedar.
Pseudotsuga taxifolia	Hemlock-spruce, red fir, etc.
Picea engelmanni	Engelmann spruce.
Larix occidentalis	Western tamarack.
Populus balsamifera	Balsam poplar.
P. trichocarpa	Cottonwood.

PROPORTION OF SPECIES.

Proportion of trees composing the forests.

I.—IN THE ENTIRE FOREST AREA[1].

Pinus monticola	33
Larix occidentalis	25
Pseudotsuga taxifolia	15
Abies lasiocarpa	8
Pinus murrayana	7
Thuya plicata	6
Picea engelmanni	3
Tsuga mertensiana	2
Pinus ponderosa	([2])
P. albicaulis	([2])
Abies grandis	([2])
Betula papyracea	([2])
B. occidentalis	([2])
Populus tremuloides	([2])
P. trichocarpa	([2])
P. balsamifera	([2])

II.—IN THE SUBALPINE ZONE.

Abies lasiocarpa	70
Pinus albicaulis	28
Picea engelmanni	1
Larix occidentalis	([2])
Pinus monticola	([2])
P. murrayana	([2])
Populus tremuloides	([2])
Pseudotsuga taxifolia	([2])

[1] In this table are included only individuals of the species enumerated having diameters near the ground of 4 inches and upward and showing a distinct trunk.

[2] Trifling.

III.—IN THE WHITE-PINE ZONE.

Pinus monticola	42
Larix occidentalis	35
Thuya plicata	8
Picea engelmanni	6
Tsuga mertensiana	3
Abies grandis	2
Species of Populus, Betula, etc	4

IV.—IN THE YELLOW-PINE ZONE.

Pinus ponderosa	10
Pseudotsuga taxifolia	70
Abies grandis	15
Species of Populus, Betula, Acer, Salix, and Amelanchier	5

Proportion of lumber trees of commercial size.

[By commercial size is understood a measurement of 16 inches and upward at the base.]

Pinus monticola	50
Larix occidentalis	41
Pseudotsuga taxifolia	5
Thuya plicata	2
Pinus ponderosa	1
Picea engelmanni	([1])
Tsuga mertensiana	([1])
Populus trichocarpa	([1])
P. balsamifera	([1])

SIZE AND AGE OF TREES.

Range in size and age of trees.

[By clear trunks is meant height to first branches of distinctive crown.]

I.—SUBALPINE ZONE, MATURE FOREST.[2]

Species.	Height.	Diameter.	Clear trunks.	Age.
	Feet.	*Feet.*	*Feet.*	*Years.*
Abies lasiocarpa	20 to 60	1 to 1½	10 to 25	40 to 100
Pinus albicaulis	20 to 50	1 to 3	0 to 20	50 to 200
Picea engelmanni	40 to 60	½ to 1½	0 to 30	30 to 90
Pinus murrayana	40 to 60	1 to 1½	20 to 25	100 to 150
Larix occidentalis	60 to 100	1 to 2	30 to 50	80 to 100
Pinus monticola	80 to 150	1 to 2½	30 to 60	50 to 120
Pseudotsuga taxifolia	30 to 100	1 to 4	0 to 60	50 to —
Populus tremuloides	20 to 25	⅓ to 1½	0	.....

[1] Trifling.

[2] The larger heights and diameters are found near the lower limits of the zone; the smaller at altitudes above 5,500 feet.

FOREST NEAR PRIEST LAKE, SHOWING CEDAR TREES BARKED TO FURNISH THATCH FOR HUTS

Range in size and age of trees—Continued.

II.—WHITE-PINE ZONE, OLD TO SECOND GROWTH.

Species.	Height.	Diameter.	Clear trunks.	Age.
	Feet.	*Feet.*	*Feet.*	*Years.*
Pinus monticola	150 to 250	2 to 5	80 to 120	200 to 375
Larix occidentalis	150 to 200	2 to 4	50 to 120	175 to 420
Pinus murrayana	60 to 100	⅓ to 1½	20 to 60	30 to 90
Pseudotsuga taxifolia	80 to 150	1½ to 2½	50 to 90	100 to 200
Thuya plicata	80 to 120	*a* 2 to 3½	25 to 60	120 to 800
Picea engelmanni	80 to 100	½ to 1½	0 to 30	50 to 120
Tsuga mertensiana	100 to 120	*b* 1⅓ to 3	0 to 30	100 to 200 to 500
Abies grandis (*c*)	20 to 70	¾ to 1	0	30 to 75
Betula papyracea	50 to 75	1 to 2	0	....
B. occidentalis	Small.	....	....	....
Populus tremuloides	20 to 40	½ to 1	10 to 20	....
P. trichocarpa	50 to 100	1½ to 3	20 to 40	....

a Rarely up to 8 feet. *b* Rarely up to 5 feet.
c Rarely 3 feet in diameter, with clear trunks 40 to 80 feet in height.

III.—YELLOW-PINE ZONE, MATURE FOREST.

Pinus ponderosa	50 to 90	1¼ to 3	20 to 40	80 to 200
Pseudotsuga taxifola	50 to 100	1¼ to 2	20 to 60	80 to 150
Abies grandis	....	Small.	....	....
Pinus murrayana	....	Small.	....	....

AREAS OF FOREST ZONES.

Areas occupied by each forest zone.

Zone.	Acres.	Per cent.
Yellow pine	60,000	10
White pine	480,000	80
Subalpine fir	60,000	10
Total	600,000	100

In estimating the areas of the different zones regard is had to the species of forest trees that grew on the various tracts before their deforestation by fires began about thirty years ago, and not to the present conditions of the burnt areas.

AMOUNT AND VALUE OF TIMBER.

Estimate of standing merchantable timber.

SAW TIMBER.

In the absence of surveys the various areas are computed from estimates as to the relative percentages that each bears to the total area embraced in the reserve, which is reckoned at 620,000 acres, exclusive of tracts permanently covered with water.

Acres.	Average per acre.	Total.
	Feet B. M.	*Feet B. M.*
134,400	4,000	537,600,000
60,800	8,000	486,400,000
28,800	20,000	576,000,000
3,840	40,000	153,600,000
150,000	1,000	150,000,000
377,840	....	1,903,600,000

In this estimate only trees having a diameter of 16 incnes at tne base are included, and only such species as are commonly sawed in this region, for enumeration of which see table on p. 245.

Living timber only is included in the above estimates. The amount of standing dead timber can not be computed even approximately. It varies from day to day, depending on the force and direction of the wind, on rain, snow, the degree of rot in the dead trunk and the position of the decay, together with the age of the burn, its location and exposure, the more or less complete burning of the humus, the character of the soil, and many other factors.

RAILROAD TIES.

Acres.	Average number per acre.	Total.
60,800	296	17,996,800
134,400	755	101,472,000
28,800	100	2,880,000
3,800	55	211,200
160,000	84	13,440,000
387,800	....	136,000,000

This gives, at 20 feet per tie, a total of 2,720,000,000 feet B. M. Trees having diameters at the ground of 8 to 16 inches are considered tie timber. The following species are included in the list:

Pseudotsuga taxifolia.
Larix occidentalis.
Tsuga mertensiana.
Thuya plicata.

Estimate of standing merchantable timber—Continued

TELEGRAPH POLES.

Acres.	Average per acre.	Total.
20, 000	30	600, 000
150, 000	10	1, 500, 000
170, 000	....	2, 100, 000

This gives, at 100 feet per pole, a total of 210,000,000 feet B. M. The only species utilized for purposes of telegraph poles in this region is *Thuya plicata*, which is not abundantly represented in the forests of the reserve.

RECAPITULATION.

Kind of timber.	Feet B. M.
Saw timber	1, 903, 600, 000
Railroad ties	2, 720, 000, 000
Telegraph poles	210, 000, 000
Total....	4, 833, 600, 000

Estimated value on root of standing timber.

Kind of timber.	Amount.	Average stumpage value.	Total value.
Saw logs....................M. feet..	1, 903, 600	$0. 50	$951, 800
Ties ....number..	136, 000, 000	.02	2, 720, 000
Poles ....do....	2, 100, 000	.05	105, 000
Total	....	....	3, 776, 800

Approximate value of timber when ready for consumption at first point of manufacture.

Kind of timber.	Amount.	Average value.	Total value.
Saw logs ....M. feet..	1, 903, 600	$10. 00	$19, 036, 000
Ties ....number..	136, 000, 000	.20	27, 200, 000
Poles ....do....	2, 100, 000	.25	525, 000
Total	....	....	46, 761, 000

Living timber only is included in above estimates. Dead timber there has no commercial value.

DESTRUCTION BY FIRES.

Estimate of merchantable timber consumed by forest fires in the last thirty years.

SAW TIMBER.

Acres.	Average per acre.	Total destroyed.
	Feet B. M.	*Feet B. M.*
134,400	1,000	134,400,000
60,800	800	48,640,000
28,800	200	5,760,000
3,840		
100,000	20,000	2,000,000,000
50,000	30,000	1,500,000,000
160,000	5,000	800,000,000
537,840		4,488,800,000

RAILROAD TIES.

	Number.	Number.
50,000		
100,000	30	3,000,000
120,000	100	12,000,000
250,000	800	200,000,000
20,000	1,500	30,000,000
540,000		245,000,000

TELEGRAPH POLES.

200,000	30	6,000,000

Estimated value of timber burned.

4,488,800,000 feet, at 50 cents per thousand	$2,244,400
245,000,000 ties, at 2 cents per tie	4,900,000
6,000,000 telegraph poles, at 5 cents per pole	300,000
Value of young growth during thirty years	1,500,000
	8,944,400
Less 5 per cent depreciation caused by windfalls, rot, etc., during thirty years	447,220
Total	8,497,180

Approximate value of timber burned at first point of manufacture.

4,488,800,000 feet saw logs, at $10 per thousand feet	$44,888,000
245,000,000 ties, at 20 cents per tie	49,000,000
6,000,000 telegraph poles, at 25 cents per pole	1,500,000
Value of young growth during thirty years	15,000,000
	110,388,000
Less depreciation in value during thirty years caused by rot, windfalls, etc	4,447,220
Total	105,940,780

SUMMARY.

Estimate of available sound timber.

	Feet.
Total amount of standing merchantable timber	4,833,600,000
Young growth less than 110 years old, from 8 to 16 inches in diameter, about 65 per cent, or	3,141,840,000
Second and old growths over 110 years old and 16 inches in diameter, about 35 per cent, or	1,691,760,000
Total	4,833,600,000
Solid young growth, about 40 per cent, or	1,256,736,000
Young growth mixed with old and second growths, about 60 per cent, or	1,885,104,000
Total young growth	3,141,840,000
Accessible solid young growth, about 60 per cent, or	754,041,600
Accessible young growth mixed with second and old growths, about 70 per cent, or	1,319,572,800
Accessible young growth	2,073,614,400
Accessible old and second growths, about 80 per cent, or	1,353,408,000
Total accessible timber, about 70.9 per cent, or	3,427,022,400

Amounts that may be safely cut from the accessible places with due regard to the strength of the forest,

	Feet.
Young growth:	
Of solid growth, about 50 per cent, or	377,020,800
In mixed old and second growths	none.
Total young growth	377,020,800
Old and second growths:	
Of old growth, reckoned at 20 per cent, about 80 per cent, or	270,681,600
Of second growth, reckoned at 80 per cent, about 30 per cent, or	406,022,400
Total old and second growths	676,704,000
Total available merchantable timber	1,053,724,800

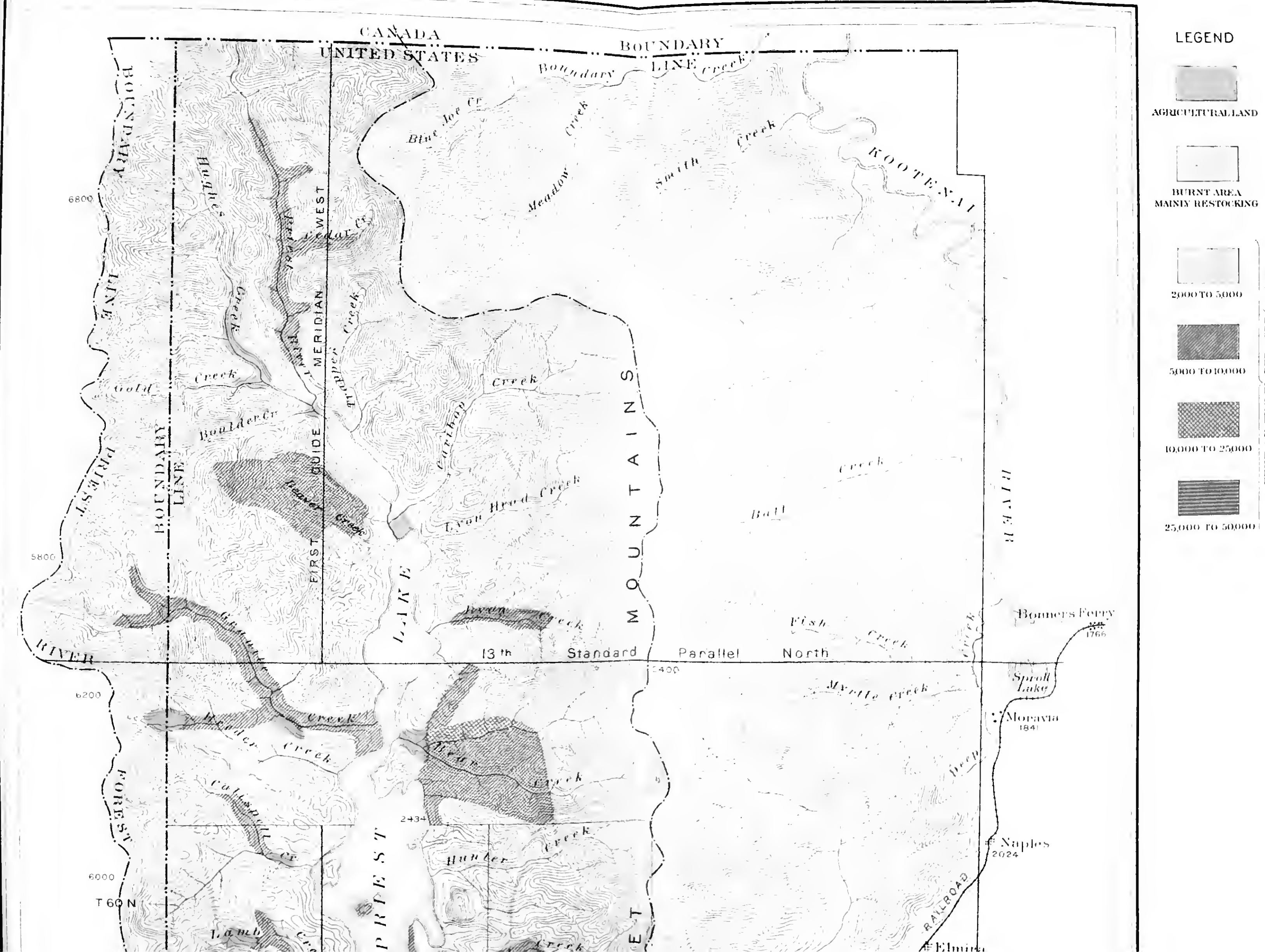
Cord wood and fencing material are excluded from above estimates. Fencing material is an uncertain factor and cord wood has no other value in the reserve than the labor expended upon it.

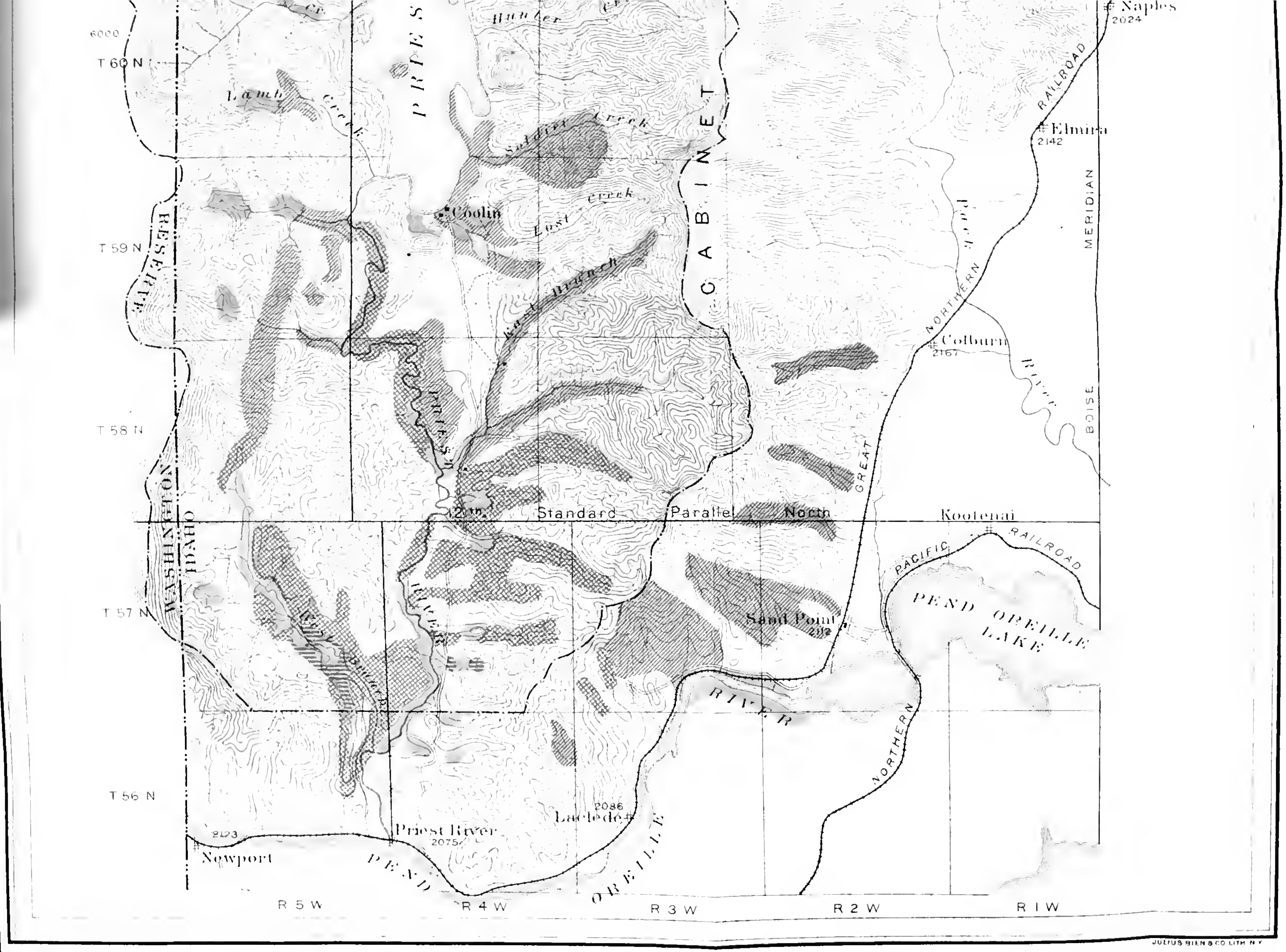
Agricultural lands.

	Acres.
Fork of Upper Priest River (Gold Creek)	300
North end of Upper Priest Lake	280
North end of Lower Priest Lake	200
Upper Granite Creek	500
Reeder Creek	1,030
Kalispel Creek	100
Bear Creek	350
Soldier Creek	200
Medly Creek	110
South end of Priest Lake	250
Junction of East and Priest rivers	425
Big Creek	160

	Acres.
Lower Priest River above rapids	300
Long Creek (Blue Creek)	250
East Pine Creek	50
Lower West Branch of Priest River, including swampy country between the heads of West Branch, Benars, Lamb, and Granite creeks	3,380
Pend Oreille Valley	1,200
Small creeks (no names)	375
Narrow strips of alder swamps along small creeks, beaver ponds, drainable lakelets, and cranberry bogs	500
Total	9,990

These areas comprise land more valuable for agricultural than for forestry purposes.

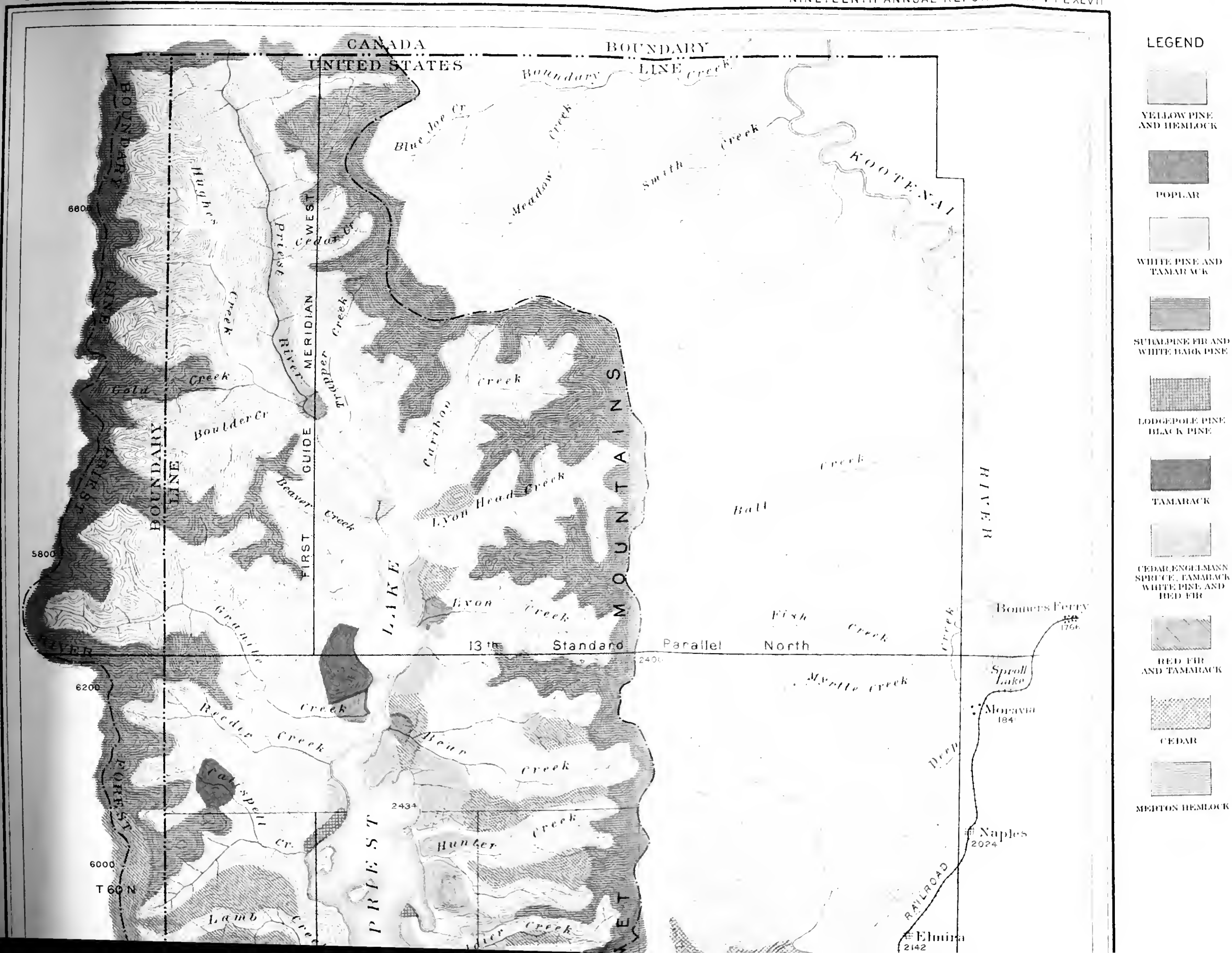

CANADA
UNITED STATES
BOUNDARY
LINE
Boundary Creek
Blue Joe Cr.
Meadow Creek
Smith Creek
KOOTENAI
RIVER
BOUNDARY LINE
Hughes
Cedar Cr.
FIRST GUIDE MERIDIAN WEST
Trapper Creek
Creek
Gold
Boulder Cr.
Caribou
Lyon Head Creek
Beaver Creek
MOUNTAINS
Ball
Creek
PRIEST
BOUNDARY LINE
RIVER
LAKE
Fish
Creek
13th Standard Parallel North
Bonners Ferry
1766
Sproll Lake
Moravia
1841
Myrtle creek
Creek
Deep
Naples
2024
RAILROAD
Elmira
FOREST
PRIEST
Hunter
Creek
Lamb
6800
5800
6200
6000
2400
2434
T 60 N
LEGEND
AGRICULTURAL LAND
BURNT AREA MAINLY RESTOCKING
2,000 TO 5,000
5,000 TO 10,000
10,000 TO 25,000
25,000 TO 50,000
FEET OF TIMBER PER ACRE (B.M.)

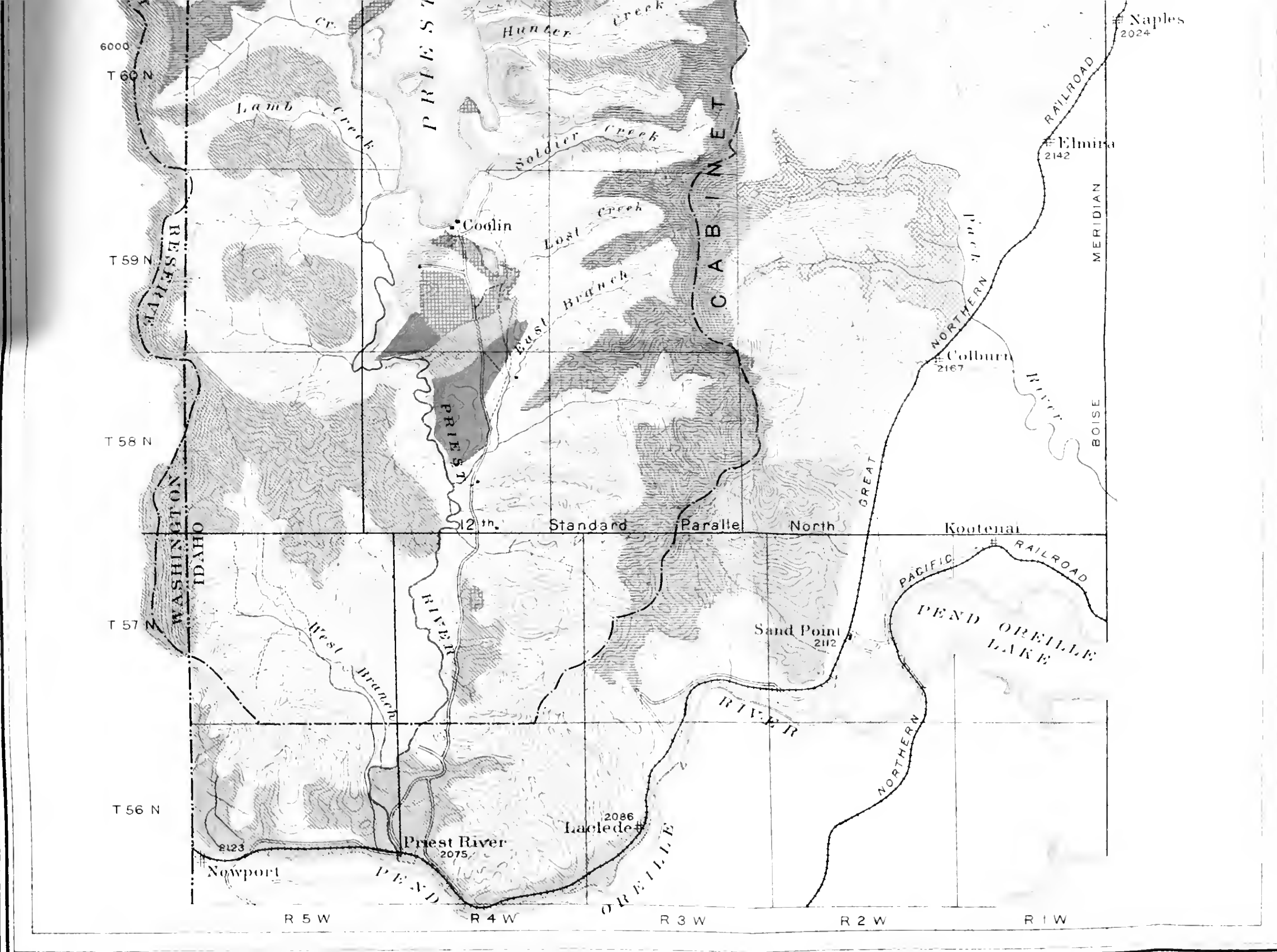


MAP OF PRIEST RIVER FOREST RESERVE
SHOWING LAND CLASSIFICATION AND DENSITY OF MERCHANTABLE TIMBER

Scale

5 0 5 10 15 MILES


CANADA
UNITED STATES
BOUNDARY LINE
Boundary Creek
Blue Joe Cr.
Meadow Creek
Smith Creek
KOOTENAI RIVER
BOUNDARY LINE
Hughes Creek
Priest River
Cedar Cr.
WEST
FIRST GUIDE MERIDIAN
Trapper Creek
Gold Creek
Boulder Cr.
Caribou Creek
Lyon Head Creek
Beaver Creek
Ball Creek
LAKE
Lyon Creek
MOUNTAINS
Fish Creek
Bonners Ferry
1766
13th Standard Parallel North
2400
Myrtle Creek
Granite Creek
Sproll Lake
Moravia
1841
Reeder Creek
Bear Creek
Deep Creek
Kalispell Cr.
2434
PRIEST
Hunter Creek
Naples
2024
RAILROAD
FOREST
Lamb Creek
Elmira
2142
6800
5800
6200
6000
T 60 N
LEGEND
YELLOW PINE AND HEMLOCK
POPLAR
WHITE PINE AND TAMARACK
SUBALPINE FIR AND WHITE BARK PINE
LODGEPOLE PINE BLACK PINE
TAMARACK
CEDAR, ENGELMANN SPRUCE, TAMARACK, WHITE PINE, AND RED FIR
RED FIR AND TAMARACK
CEDAR
MERTON HEMLOCK



MAP OF PRIEST RIVER FOREST RESERVE
SHOWING THE DISTRIBUTION OF THE PRINCIPAL TIMBER SPECIES

Scale

5 0 5 10 15 MILES

DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

THE

STANISLAUS AND LAKE TAHOE FOREST RESERVES AND ADJACENT TERRITORY

BY

GEORGE B. SUDWORTH

EXTRACT FROM THE TWENTY-FIRST ANNUAL REPORT OF THE SURVEY, 1899-1900
PART V, FOREST RESERVES—HENRY GANNETT, CHIEF OF
DIVISION OF GEOGRAPHY AND FORESTRY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

STANISLAUS AND LAKE TAHOE FOREST RESERVES, CALIFORNIA, AND ADJACENT TERRITORY

BY

GEORGE B. SUDWORTH

CONTENTS.

ILLUSTRATIONS.

STANISLAUS AND LAKE TAHOE FOREST RESERVES, CALIFORNIA, AND ADJACENT TERRITORY.

By George B. Sudworth.

INTRODUCTION.

The information presented in this report is based on a personal reconnaissance of the territory, made during the summer of 1899. The half-tone illustrations are from photographs taken at the same time.

The lack of railroad facilities and the insufficient number of stage lines made it necessary to perform the necessary travel on horseback, with an attending pack outfit.

Much of the territory examined has, from the value of its mineral and other resources, been long traversed by miners and other transient settlers. As a result the region is penetrated and crossed in certain portions by a number of rough wagon roads (see Pl. XCI, *B*) and innumerable intricate trails. Unfortunately, however, several important wagon roads and trails used by early emigrants have been abandoned and are now so thickly overgrown by forest trees as to be impassable. This fact and the roughness of the country made it difficult to penetrate some parts of the territory studied.

The western part of the territory is directly accessible by roads and trails and the country is of such a nature as to allow direct routes, while much of the eastern part can not be reached except by long detours. This is due to the existence of deep, impassable canyons.

The territory was traversed by crossing and recrossing from east to west at sufficient intervals to afford an accurate idea of the composition of the forests and also of the areal and altitudinal distribution of the timber species. In order to make the examination still more comprehensive, many side trips were made into territory lying between the regular routes of travel. General features and the relationships of different forest types were studied from numerous elevations throughout the region. The composition of the various types of forest and the relative abundance of timber and other tree species was determined by careful study and measurements of sample wooded areas.

These sample areas were so selected from various parts of commercial forests that it is believed an adequate idea of composition and stand was thus obtained for the entire region examined.

About 500 photographs were taken as an integral part of field notes, and also with a view to securing a systematic photographic description of all the forest and related features of the region. A part of these pictures are reproduced for illustration in the present report.

BOUNDARIES.

LAKE TAHOE FOREST RESERVE.

The boundaries of this reserve are as follows:

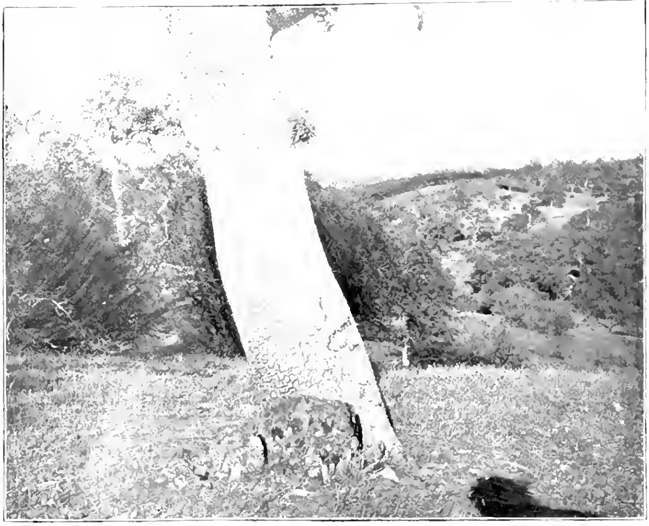
Townships eleven (11), twelve (12), and thirteen (13) north, range sixteen (16) east, Mount Diablo base and meridian, California; townships eleven (11), twelve (12), and thirteen (13) north, range seventeen (17) east, and so much of township eleven (11) north, range eighteen (18) east, as lies west of the summit of the Sierra Nevada Range of mountains in El Dorado County, California.

The area is 213 square miles, or 136,335 acres.

STANISLAUS FOREST RESERVE.

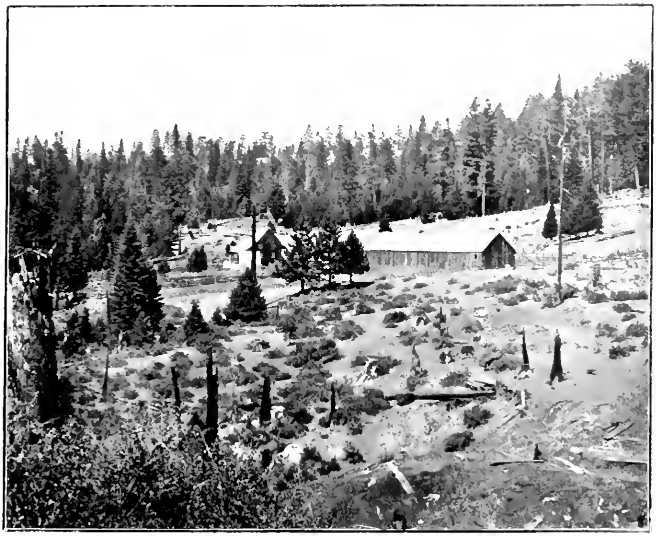
Beginning at the southeast corner of township three (3) north, range twenty-four (24) east, Mount Diablo base and meridian, California; thence northerly along the range line to the northeast corner of said township; thence westerly along the township line to the northwest corner of said township; thence northerly along the range line to the township line between townships four (4) and five (5) north, range twenty-three (23) east; thence easterly along the township line to the southeast corner of township five (5) north, range twenty-three (23) east; thence northerly along the range line to the northeast corner of said township; thence westerly along the first (1st) standard parallel north to the southwest corner of township six (6) north, range twenty-two (22) east; thence northerly along the range line between ranges twenty-one (21) and twenty-two (22) east to the northeast corner of township seven (7) north, range twenty-one (21) east; thence westerly along the township line to the northwest corner of said township; thence northerly along the range line to the northeast corner of township eight (8) north, range twenty (20) east; thence westerly along the surveyed and unsurveyed township line between townships eight (8) and nine (9) north to the northwest corner of township eight (8) north, range seventeen (17) east; thence southerly along the range line to the southeast corner of township eight (8) north, range sixteen (16) east; thence easterly along the unsurveyed township line to the point for the southeast corner of township eight (8) north, range seventeen (17) east; thence southerly along the unsurveyed and surveyed range line between ranges seventeen (17) and eighteen (18) east, subject to the easterly offset on the first (1st) standard parallel north, to the southeast corner of township four (4) north, range seventeen (17) east; thence easterly along the township line to the northeast corner of township three (3) north, range eighteen (18) east; thence southerly along the range line to the southeast corner of said township; thence easterly along the township line between townships two (2) and three (3) north to the southeast corner of township three (3) north, range twenty-four (24) east, the place of beginning.

The area is 1,080 square miles, or 691,200 acres.

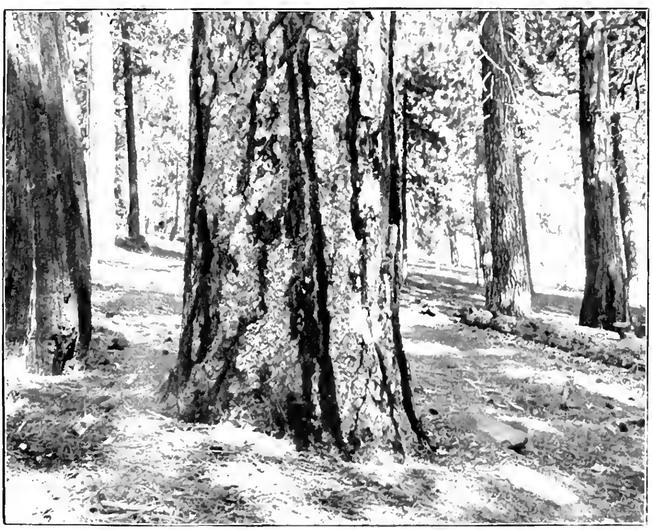


A. CALIFORNIA WHITE OAK (QUERCUS DOUGLASII HOOK AND ARN.), SOUTHERN CALAVERAS COUNTY.

B. TYPICAL WAGON ROAD IN YELLOW PINE FOREST, SOUTHWESTERN SECTION OF STANISLAUS FOREST RESERVE.



A. LONG BARN, A TYPICAL ROAD STATION IN YELLOW-PINE BELT, NORTH FORK OF TUOLUMNE RIVER



B. INTERIOR OF YELLOW-PINE FOREST ON NORTH FORK OF TUOLUMNE RIVER

TERRITORY EXAMINED.

The territory examined is comprised in the six following atlas sheets of the United States Geological Survey: Big Trees, Pyramid Peak, Placerville, Jackson, Dardanelles, and Markleeville. Practically all of the Lake Tahoe and Stanislaus forest reserves are included in these quadrangles.

Roughly estimated, the area of the territory examined amounts to 5,116 square miles, or about 3,270,000 acres.

GENERAL TOPOGRAPHIC FEATURES.

This region is representative of the general character of the Sierra Nevada, the high crests of which are reached by a long rise from the broad San Joaquin River Valley. The western border of the region has an altitude of about 500 feet, which increases to 10,000 feet and over as the summit is reached. This general slope is made up of rolling, wide valleys and low, soil-covered foothills on the west, while going eastward the valleys grow smaller and the foothills are replaced by high, rocky mountain ranges and peaks. Scattered among these high ranges are a few large subalpine lakes, the principal of which are Lake Tahoe and Fallen Leaf Lake. Cascade, Echo, Blue, Silver, and Loon lakes are important, but much smaller. Most of these lakes are situated in the north-central part of the region examined. Smaller lakes, ponds, and marshes are more or less common among the high mountains (Pls. CV, *B*, and CVIII, *A*).

The salient features in the eastern or more mountainous part of the territory are the high peaks known as the Dardanelles, Pyramid Peak, Mokelumne Peak, Round Top, Elephants Back, Jacks Peak, Dicks Peak, Mount Tallac, and Rubicon Peak. These peaks rise from high, rocky ranges, and have altitudes ranging from 9,000 to 10,400 feet. There are also numerous lesser peaks, ranging from 8,000 to 9,000 feet in elevation. The common elevation of the mountain valleys and canyon bottoms in the region of these peaks is from 5,000 to 7,000 feet.

Equally striking features in the general topography of the region are the deep river canyons which traverse the country more or less from northeast to southwest. Five important rivers and their numerous tributaries drain the region. The Rubicon River and the North and Middle forks of American River drain the northwestern and northern border of the region, while the South Fork of American River crosses the entire northern part, the headwaters of this stream lying south of Lake Tahoe. The North, Middle, and South forks of Cosumnes River lie mainly in the west-middle portion of this territory, while a few head branches extend eastward about halfway across the region. The upper main Mokelumne River and its North Fork cut the south half of this region from east to west, and this, with

American River, is the only stream which completely crosses the strip of country studied.

Calaveras River drains only the southwestern part, while the North, Middle, and South forks of Stanislaus River drain the south-central and southeastern portion of the region.

These streams and their larger tributaries are similar in general character. Except for parts of the streams within the west border of the region, the beds of these rivers are rough with huge bowlders and lie in deep gorges, canyons, or narrow valleys (see Pls. XCVII, *A*, and CVII, *A* and *B*). At high water the principal rivers in the middle and eastern sections vary from 10 to 20 yards in width, and the main channels of these streams in the western sections are from 25 to 50 yards in width. The depth of water carried during the dry months—August, September, and October—ranges from 3 or 4 inches to 1 or 2 feet, while several of even the larger streams contained no water at all, or only a few pools (see Pls. CVII, *A* and *B*, and CXII *A*). Low water is most common in the western sections of the region. This scarcity of water, or entire lack of it, is, however, partly explained by the fact that numerous large ditches, supplying mining camps and other settlements, take large quantities of water from near the headwaters of all these streams.

As a rule, the flow of streams in the high mountain region is very rapid, while in the western sections the fall in the streams is much less, and the water flows slowly (see Pl. CXII, *A*).

The sides of the canyons are usually rocky and steep, especially in the eastern sections, while in some localities they are precipitous or almost perpendicular walls of granite rock (see Pls. XCVII, *A*, CVII, *B*, CVIII, *B*, and CXIV, *B*).

Where soil is present it is for the most part a light-brown clayey loam. A very striking feature, however, of the eastern and northern sections is that the surface of the mountains is bare granite rock, supporting the tree and other growths in pockets and crevices of the rock, or on small soil-covered rocky benches (see Pls. XCVI, *B*, and CVIII, *B*).

WATER SUPPLY.

Only a general impression could be gained as to the supply and consumption of water in this region. But it may be safely stated that the natural supply of water for all purposes is generally adequate during the dry months. A few localities were found where the local wells, springs, and streams were dry, forcing the settlers to haul water from distant sources.

SETTLEMENTS.

Although the territory has been thoroughly explored and long traversed by miners, lumbermen, shake makers, and by sheep herders

A. JEFFREY PINE (PINUS JEFFREYI OREG. COM.) 4 FEET IN DIAMETER

This shows best form of timber trees in yellow-pine belt, headwaters of South Fork of Stanislaus River, Stanislaus Forest Reserve.

B. WHITE FIR (ABIES CONCOLOR PARRY) 4½ FEET IN DIAMETER.

Headwaters of South Fork of Stanislaus River, Stanislaus Forest Reserve.

and cattlemen, there is little permanent settlement except in the southwestern and western sections. The principal towns in these sections are Confidence, Columbia, Robinsons Ferry, Vallecito, Murphy, Sheep Ranch, Mountain Ranch, Lotus, Coloma, Georgetown, Amador, Sutter Creek, Angels, San Andreas, Mokelumne Hill, Jackson, and Placerville, the last eight being the largest and most important. Nearly all are situated at elevations between 1,000 and 2,000 feet. The location and permanency of these settlements is determined by the presence and continuance of mining interests. With few exceptions, the agricultural and horticultural interests of these localities are merely incidental.

Throughout the more mountainous territory there are numerous unimportant points called settlements, which are chiefly temporary lumber "camps," provision stores, toll houses, taverns, and feed stations, or isolated cabins occupied by transient settlers during the summer months only. Temporary post-offices are located at a few of these mountain points, and are reached by rough wagon roads. Summer resorts are maintained at several points on Lake Tahoe for the benefit of tourists. The resorts within the territory examined are Tallac post-office at the southwest extremity of the lake, and two others—Murphy and Tahoe post-offices—on the west side of Lake Tahoe. Communication with these points and railroad connection at the north end of the lake is maintained by small steamers. Land communication with these resorts is only by rough trails.

As already stated, the mountain settlements, or most of those at elevations above 3,000 feet, are temporary, being occupied during the summer only. This is due to the heavy winter snows, which prevent communication with the lower permanent villages from which the mountain settlements derive nearly all provisions and other supplies. Very few people remain in this snowy region during the winter, the majority leaving by the middle or last of October.

INDUSTRIES.

The principal industries of this territory are, in order of their importance, gold and copper mining, grazing, agriculture and fruit growing, and lumbering and allied timber industries.

MINING.

Mining is carried on chiefly in the southern and western sections, and is concerned mostly with the production of gold. Only three important copper mines were found. These were near Campo Seco and Copperopolis. The largest mining operations are confined to the vicinity of the various towns mentioned as permanent settlements, while a large number of small operations are carried on more or less distant from these places (see Pl. CX, *A*).

At present deep-shaft mining is resorted to almost entirely, and as this requires the use of expensive machinery, it is possible for only large capital to carry on such operations (see Pl. CXIV, *A*). Placer mining and shallow pocket mining in quartz are carried on in many localities by individuals whose equipment consists of a shovel, pick and sluice or hand drill, and a few sticks of dynamite. With few exceptions, the returns from these forms of mining appear to be small. The thrifty Chinaman, who is satisfied with the small but sure daily income from washing the gravel and silt of river beds, is the only one of these poorer miners who is improving his condition.

The highly profitable placers of the early fifties and sixties appear to be generally exhausted. In all the foothill sections everywhere there is evidence of former extensive mining of this kind, where now there are standing forests of 50-year-old trees. Towns at one time of some importance have disappeared, and their sites are now marked only by heaps of gravel, the ruins of log cabins, and crumbling stone chimneys.

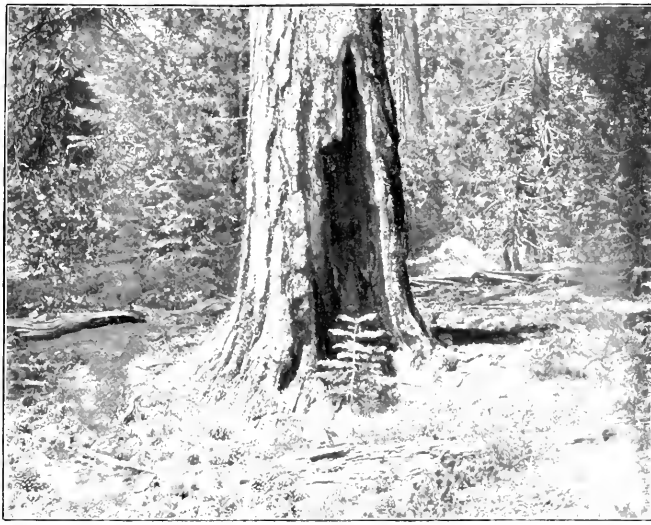
The larger mining operations of the present time give the principal life to the small towns. They are important to the region also, as they afford a market for the lumber derived from the higher wooded country and for agricultural and other products from the lower hill and plains districts. Owing, however, to the lack of railroad facilities, all commodities are freighted long distances by teams and are high priced in proportion to the distance hauled.

GRAZING.

Grazing is an important industry throughout this region in connection with the production of beef, mutton, wool, and butter. The grazing of cattle for beef and the grazing of stock cattle for dairy products are separate industries, and there is also the grazing of sheep and goats. The grazing of beef cattle and sheep is the largest of these industries. With some exceptions sheepmen are not landowners, but depend for forage on transiently hired pasturage or, to a greater extent, on the public domain. Cattle raisers are more often owners of ranches in the foothills or valleys, where for a portion of the year their stock is cared for.

The low valleys and foothill country of the southern and western sections afford grazing for both stock and beef cattle, and also for sheep during the fall, winter, and spring. About July, however, cattle and sheep are driven for the summer to ranges in the high mountain regions, from which they are withdrawn by the middle or last part of October. No animals are intentionally left in the mountains during winter on account of the deep snow.

Most of the cattlemen claim to own large tracts of the mountain land, a portion of which is fenced, but the larger part of the range used by



A. YELLOW PINE (PINUS PONDEROSA LAWS.) · FEET IN DIAMETER

Near Middle Fork of Stanislaus River, west section of Stanislaus Forest Reserve

B. CHARACTERISTIC DISTRIBUTION OF YELLOW PINE IN FORESTS

East slope of Middle Fork of Stanislaus River, between Cow Creek and L[illegible] Creek, Stanislaus Forest Reserve.

beef cattle is unfenced forest land. Simple cabins are maintained on the fenced parts of the range and are the headquarters of the riders who, in this exceedingly rough and broken country, are obliged to follow the drifting of cattle during the entire summer (see Pl. XCV, A). If a careful watch is not kept on the general movement of the cattle, many animals are likely to be missed in the fall round-up. Dairy ranchmen graze their herds entirely within fenced ranges in the higher mountains, always including as much alpine meadow land as possible. The extreme precautions taken by dairymen not to lose animals from their herds, even on a fenced range, is illustrated by the fact that every animal wears a bell. The din raised by 300 or 400 of these cattle close to camp at night is not conducive to slumber.

The necessity for constantly seeking new pasture makes it impossible for sheepmen to maintain headquarters at one point in the mountain range longer than a week or two at most, but they graze their flocks over areas within boundaries fixed by common consent, or by priority of possession from year to year. The ranges used by sheepmen are usually those not claimed or used by cattlemen, for, although sheep will graze after cattle, the latter will not graze after sheep. On account of this, and also because forage is exceedingly short on all the unfenced mountain ranges, very bitter feeling exists between cattlemen and sheepmen. The latter are constantly encroaching not only on unfenced but also on fenced cattle ranges. When discovered these encroachments are resented, and sometimes result in the destruction of large numbers of sheep and not infrequently in the loss of human life on both sides.

AGRICULTURE AND AGRICULTURAL LANDS.

Agriculture, including also fruit growing, is a relatively small industry in this region for the reason that only a small percentage of the total area is available for this purpose. As shown by the accompanying maps (Pls. LXXXV–XC), the most extensive tracts of agricultural lands lie near the western and southwestern borders, at elevations of from 500 to 1,500 feet. Small isolated bodies of arable land are found in the narrow valleys of the foothills, while still smaller parcels are found throughout the western half of this region at elevations ranging from 2,000 to 3,000 feet. Most of these small tracts are near mining towns, which afford markets for the fruit and hay produced. Unlike the ranchmen of lower elevations, who depend entirely on agriculture or fruit growing, or both combined, many of the ranchmen of the foothills and mountain valleys derive only a part of their support from tillage. They resort also to hauling lumber, mining-timber, wood, ore, hay, etc.

Wheat hay and barley hay are the principal forage crops raised. Alfalfa and timothy are raised for hay in the lower broad river valleys, and also in the Carson Valley country, but with these exceptions the hay of this region consists mainly of wheat and barley cut and cured when from one-half to two-thirds ripe. A wild oat (*Avena*), which grows very abundantly without cultivation on all the foothills, is extensively cut for hay, but is a poor substitute for the more nutritious wheat and barley. Comparatively little wheat and barley are cut for grain, except in the larger border agricultural districts. The bulk of the grain comes from grain-producing centers west and southwest of this region.

The highest altitude at which wheat and barley were seen growing in the mountain valleys was 5,000 feet, which is exceptionally high, as, for the most part, these grains are not grown above 3,000 feet.

Practically none of these agricultural lands are irrigated, the main grain and hay crops depending entirely on the fall and spring rains. The lack of irrigation water makes it impossible to raise alfalfa and other perennial forage crops, as they can not survive the long drought which succeeds the spring rains. Crops of this kind were seen only in the lower moist river bottoms near the southwestern border of this region.

Fruit growing is not a large industry, and, like the more extensive agricultural operations, is carried on chiefly in the southwestern and western border valley and hill country below 1,000 feet elevation. Small fruit ranches are occasionally found in the vicinity of settlements as high as 3,500 feet, but usually not above 1,500 feet.

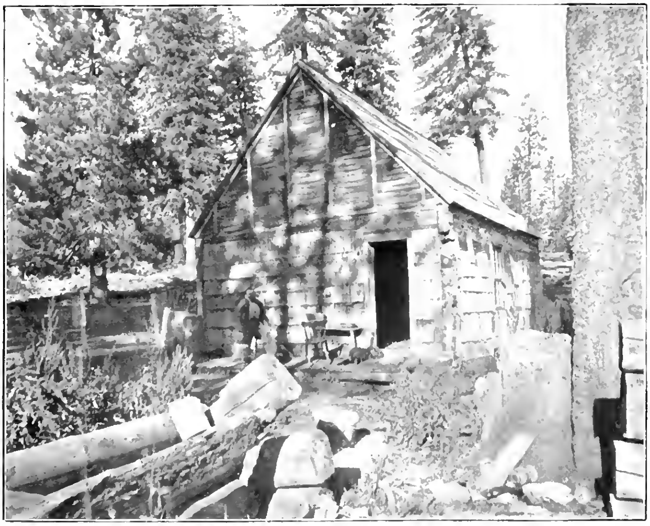
The fruits raised are mostly wine grapes, peaches, apricots, almonds, pears, and apples of small size and inferior quality. English walnuts are also raised to a limited extent, and near Coloma and Campo Seco a few hundred orange trees were seen in bearing.

The quantity of fruit produced is comparatively small, and in some localities is annually growing less and of poorer quality, while a great many vineyards have been abandoned. Total failures and small and decreasing production are said to be due, however, to the scanty rainfall of recent years and the general lack of irrigation water. Large almond orchards in the southwestern hill country failed to mature their heavy crops during 1899 on account of lack of rain.

LUMBERING.

Lumbering is carried on in the south-central and middle districts, and the output of all sawmills is consumed largely at the shaft mines and towns in the vicinity. The following nine sawmills are the principal and largest:

Bradford mill, on and near the headwaters of the North Fork of Tuolumne River; McKay mill, on the headwaters of Love Creek (tributary of North Fork of Stanislaus River); Monuele mill, near the mouth of Moran Creek (tributary of above river); Whitmore mill, on the head-



A. CATTLE HERDER'S SUMMER CABIN, BEAR MEADOWS STANISLAUS FOREST RESERVE.

B. CALIFORNIA RED FIR (ABIES MAGNIFICA MURR.) 39 INCHES IN DIAMETER

West slope of Middle Fork of Stanislaus River, near headwaters of Lily Creek. Stanislaus Forest Reserve.

waters of Mill Creek (tributary North Fork of Mokelumne River); Banner mill, on the headwaters of Jesus Maria Creek (tributary North Fork of Calaveras River), a few miles north of Mountain Ranch; Beech mill, near the head of Big Iowa Canyon (tributary to South Fork of American River), 18 miles northeast of Placerville; Blair's mill, in Sly Park, on the middle course of Sly Park Creek (tributary North Fork of Cosumnes River); Chicacola mill, near the headwaters of the South Fork of Cosumnes River; Twelvemile House mill, near the head of Deep Canyon (tributary of Pilot Creek, a south branch of the Middle Fork of American River).

The following five sawmills are the smallest and least important in the region:

Loon Lake Flume Company mill, 8 miles southwest of Loon Lake on a branch of Little Gerlé Creek; McCarty and Bruce mill, near West Point; Barclay mill, 2 miles north of Indian Diggins; Blue Lakes Water Company mill, near the head of Bear River; and a very small mill (owner unknown) 3 miles northeast of Pleasant Valley on Clear Creek.

A nearly equal number of abandoned sawmills were found throughout the regions in which the present active mills are located. Most of these old mills were abandoned for lack of saw timber. The work of these mills dates back from fifteen to twenty years.

The active mills have been in operation from one to ten years, and the daily capacity of the larger ones is comparatively greater than those of former times and is from 7,000 to 15,000 feet B. M., while the smaller mills cut from 2,000 to 6,000 feet per day. The period of activity is from April to November. A common practice of mill operators is to consume all saw timber in a radius from the plant of from 2½ to 3 miles, and then move to another site. Logs are hauled to the mills chiefly by two- and four-wheeled trucks (see Pl. CX, *B*), or occasionally by the combined use of horse tram cars and steel cables and donkey engines. The timber cut is mainly yellow pine. In some localities, however, 25 to 40 per cent of the cut consists of white fir, red fir, sugar pine and Jeffrey pine, the latter, however, passing for yellow pine. Incense cedar is sawed for telephone and telegraph poles. The lumber cut from the other kinds mentioned consists largely of inch boards, planking, and large square timber.

All the lumber manufactured is consumed within the region.

TIMBER INDUSTRIES ALLIED TO LUMBERING.

There are, in addition to sawmill operations, two other important timber-consuming industries. These are the cutting of round and rived mining timber and shakes. The round timber is extensively used for heavy props in all shaft mining, while the rived material, known as lagging, is used for minor stay work in these mines (see Pl.

(CXIII, *B*). The riving of shakes, which are a common substitute for shingles, is an old and important industry. A very large number of ordinary dwellings and other buildings throughout the region are roofed and a great many sided also with this material. The newer buildings of the larger towns, especially those near railroad communications, are roofed with sawed shingles, but prior to the advent of railroads in the foothill region, shakes were the only roofing material used.

Round mining timber and lagging are derived entirely from yellow and Jeffrey pine, while shakes are made almost entirely from sugar pine, yellow pine and white fir being seldom used.

FOREST LAND.

Seventy-five or 80 per cent of this region is more or less wooded. In traversing this area from the lowest to the highest timber line there are three natural divisions which can be made in the forest land. These are: First, a narrow belt of thinly stocked woodland, occupying the foothills and ranging from an elevation of about 500 feet up to about 2,000 feet; second, a broader, more or less dense and important belt of timber forest, extending from about 2,000 feet elevation up to 6,000 feet; third, a belt of open, less important timber forest, ranging from about 6,000 feet elevation up to 8,500 and 9,500 feet. These higher elevations represent the variation of timber line. For convenience these divisions may be termed the lower, middle, and upper timber belts.

The lower or foothill belt merges on the west into rolling grass lands with only very scattered tree growth, forming where this practically disappears an irregular line running in a northwest-southeast direction. Tongues of the lower tree belt extend eastward into the middle belt, forming where they terminate an equally irregular line. The line of separation between the middle and upper timber belts is similarly intricate.

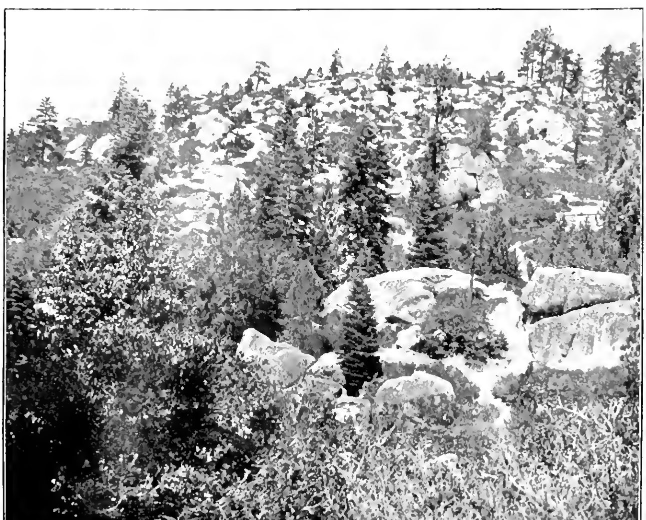
The basis of this separation into timber belts is the more or less regular occurrence of certain timber trees within successive intervals of altitude. The lines of separation are very irregular and not always sharply defined, for there is a greater or less overlapping where the species of adjoining belts come together. But the lines separating these belts are perfectly discernible where, for example, the species of the lower belt cease, and the species of the next higher belt appear.

GENERAL CHARACTER AND DISTRIBUTION OF FORESTS.

The general character of the three timber belts which make up the forests of this region is strikingly different. The lower belt is rightly termed woodland of little commercial value, while the middle belt is a

A. SUGAR PINE (PINUS LAMBERTIANA DOUGL) 50 INCHES IN DIAMETER

West slope of Middle Fork of Stanislaus River, near headwaters of Cow Creek Stanislaus Forest Reserve



B. CHARACTERISTIC SCATTERED AND STUNTED GROWTH OF CALIFORNIA RED FIR, JEFFREY PINE AND JUNIPER

High rocky summits on headwaters of Lily Creek, Stanislaus Forest Reserve

true timber forest of the highest commercial value, both on account of the quality and quantity of its timber and also on account of accessibility. Covering large watersheds, it is also of great value as protective forest. The upper belt is in part a timber forest, but altogether of less commercial value than the middle section, because of inaccessibility and the poorer quality and smaller quantity of timber it contains. The greatest value of this high mountain forest lies in the protection it gives to the headwaters of important streams.

The lower belt comprises a thinly stocked open forest mostly of oak at the lowest elevations, with a preponderance of scrubby pine at the higher elevations (see Pl. XCI, *A*). Interspersed throughout this growth are strips of valley grass land ranging in size from 100 to 1,000 acres or more. In the southwestern border sections low, broad hills of considerable extent are frequently covered with a dense growth of heath brush.

The trees of this belt are usually low, of small diameter, crooked, and much scattered, admitting everywhere a thick growth of annual grasses.

The middle timber belt is characteristically coniferous. Pines predominate at the lower elevations, but in the higher sections cedar and fir are mingled with the pines in more or less equal numbers. These trees constitute the principal forest growth and are the commercially important features of the belt. As a rule the growth is continuous but rather open (see Pls. XCII, *B*, and XCIV, *B*); there are, however, areas of considerable extent on broad benches where the forest is dense (see Pl. CVI, *B*). The trees are usually of large dimensions. A few small, unimportant broad-leafed trees predominate along streams in the bottoms of canyons, and in some places mingle in extended patches with the general coniferous growth.

The upper forest belt is likewise coniferous in character, but the bulk of this timber is fir, with mingled areas of inferior pines, juniper, and hemlock. The lower elevations, including soil-covered, rocky benches and the mucky borders of subalpine meadows, contain the denser growths, while the bare, rocky, higher elevations have only a very scattered growth of stunted trees (see Pl. XCVI, *B*). The size and quality of the timber in this belt is inferior to that of the middle belt. The firs are the only large trees in the upper region, and these do not compare in size or value with the pines and firs of the middle region.

COMPOSITION OF FORESTS.

The following lists of trees show the various species found in the forests of this region. The appearance of a few species in the lists of two separate regions indicates a wide overlapping, which will be discussed later.

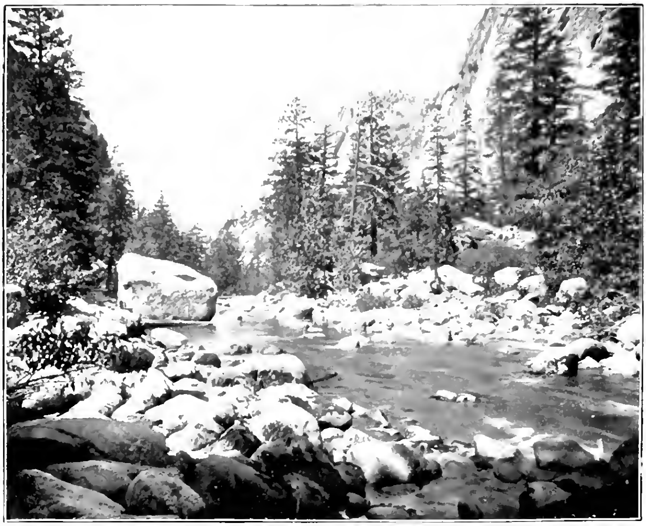
Composition of forest in Lake Tahoe and Stanislaus forest reserves, California.

LOWER BELT.

Gray pine	Pinus sabiniana Dougl.
Western black willow	Salix lasiandra Benth.
Silver-leaf willow	Salix sessilifolia Nutt.
Fremont cottonwood	Populus fremontii Wats.
California white oak	Quercus lobata Née.
California rock oak	Quercus douglasii Hook. & Arn.
Curl-leaf scrub oak	Quercus dumosa var. revoluta Sarg.
Morehus oak	Quercus morehus Kell.
California laurel	Umbellularia californica (Hook. & Arn.) Nutt.
California live oak	Quercus wislizeni A. de C.
Christmas berry	Heteromeles arbutifolia (Poir.) Roem.
Oregon maple	Acer macrophyllum Pursh.
California buckeye	Æsculus californica (Spach.) Nutt.
Coffee berry	Rhamnus purshiana de C.
Oregon ash	Fraxinus oregona Nutt.
Pale elder	Sambucus glauca Nutt.

MIDDLE BELT.

Sugar pine	Pinus lambertiana Dougl.
Yellow pine	Pinus ponderosa Laws.
Jeffrey pine	Pinus jeffreyi Oreg. Com.
Red fir	Pseudotsuga taxifolia (Poir.) Britt.
White fir	Abies concolor (Gord.) Parry.
California red fir	Abies magnifica Murr.
Big tree	Sequoia gigantea.
Incense cedar	Libocedrus decurrens Torr.
Pacific yew	Taxus brevifolia Nutt.
California torreya	Tumion californicum (Torr.) Greene.
Black cottonwood	Populus trichocarpa Torr. & Gr.
White alder	Alnus rhombifolia Nutt.
Golden chinquapin	Castanopsis chrysophylla (Hook.) de C.
Canyon live oak	Quercus chrysolepis Liebm.
California black oak	Quercus californica (Torr.) Coop.
Tan-bark oak	Quercus densiflora Hook. & Arn. Quercus densiflora var. echinoides (R. Br. Campst.) Sarg.
California scrub oak	Quercus dumosa Nutt.
Short-flower mahogany	Cercocarpus parvifolius var. breviflorus (Gr.) Jones.
Western chokecherry	Prunus demissa (Nutt.) Walp.



A. CANYON OF MIDDLE FORK OF STANISLAUS RIVER AT DONALDS FLAT.

Looking south from near the mouth of Dardanelles Creek. Stanislaus Forest Reserve.

B. WESTERN JUNIPER (JUNIPERUS OCCIDENTALIS HOOK.) [illegible] AND [illegible] INCHES IN DIAMETER

Northwest border of Stanislaus Forest Reserve.

Pacific plum	Prunus subcordata Benth.
Oregon maple	Acer macrophyllum Pursh.
Coffee berry	Rhamnus purshiana de C.
Pacific dogwood	Cornus nuttallii Aud.
Madroña	Arbutus menziesii Pursh.

UPPER BELT.

Western white pine	Pinus monticola Dougl.
White-bark pine	Pinus albicaulis.
Jeffrey pine	Pinus jeffreyi Oreg. Com.
Lodgepole pine	Pinus murrayana Oreg. Com.
Black hemlock	Tsuga pattonii Balf.
White fir	Abies concolor (Gord.) Parry.
California red fir	Abies magnifica Murr.
Western juniper	Juniperus occidentalis Hook
Aspen	Populus tremuloides Michx.
Paper-leaf alder	Alnus tenuifolia Nutt.
Bitter cherry	Prunus emarginata (Dougl.) Walp.
Dwarf maple	Acer glabrum Torr.

CHARACTER AND DISTRIBUTION OF SPECIES.

LOWER BELT.

Abundant and Important Trees.

Two species are conspicuous in this belt and deserve special notice. These are the gray pine and California rock oak.

GRAY PINE.

The gray pine is the only pine found in the lower belt, and, together with the California rock oak, forms the conspicuous open tree growth on all the dry, gravelly foothills. Its range in altitude is from 500 to 3,000 feet, the region of greatest abundance being between 1,000 and 2,000 feet elevation. This pine shows a marked tendency to stretch beyond its general limits into the middle pine belt. Straggling lines are thus frequently seen extending beyond the main range, and in a few localities detached groups were found well up among the yellow pine of the middle region.

The gray pine is in no sense a timber tree. Its form is usually scraggy, with a low, much-branched crown and very little clear trunk; in most cases even the largest trees bear stout limbs nearly to the ground. Thirty to forty years ago this pine is said to have been very abundant, of large size, and to have formed continuous forests of considerable density. At the present time, however, the stand is thin and composed chiefly of trees from 10 to 40 feet in height. Occasional old trees, 60 to 80 feet high, are found towering far above the present growth. These are doubtless remnants of the original forest. The common diameter of this species ranges from 12 to 24 inches, while the occasional old trees are from 28 to 37 inches in diameter.

The reproduction of this pine is abundant. Wherever surface fires have not occurred frequently, seedlings spring up rapidly and cover the driest and rockiest hills and shallow valleys.

CALIFORNIA ROCK OAK.

The only conspicuous broad-leaf tree of this belt is the California rock oak (see Pl. XCI, A). Like the gray pine, it is not a timber tree. It spreads over the lowest foothills, forming a very open forest, in which scattered low brush and abundant annual grasses thrive. It occurs on the foothills farther westward and considerably outside of the region under consideration. Within this region the distribution is between 300 and 1,500 feet elevation, and is most common between 500 and 1,000 feet. It is rather exclusive, not generally mingling with other species, and then only with the gray pine. Areas, rather than individuals of the two species, are more often mingled.

As a rule the California rock oak occurs on the richer hill soils, occasionally, as stated, sharing poor gravelly and stony sites with the gray pine. Stragglers of this oak are occasionally found within the middle pine belt, especially in shallow valleys or along small streams. The trunks of the California rock oak are short and crooked, and the crown is much branched (see Pl. XCI, A). Diameter measurements range from 14 to 24 inches or, exceptionally, 28 inches. The usual height is 25 to 40 feet.

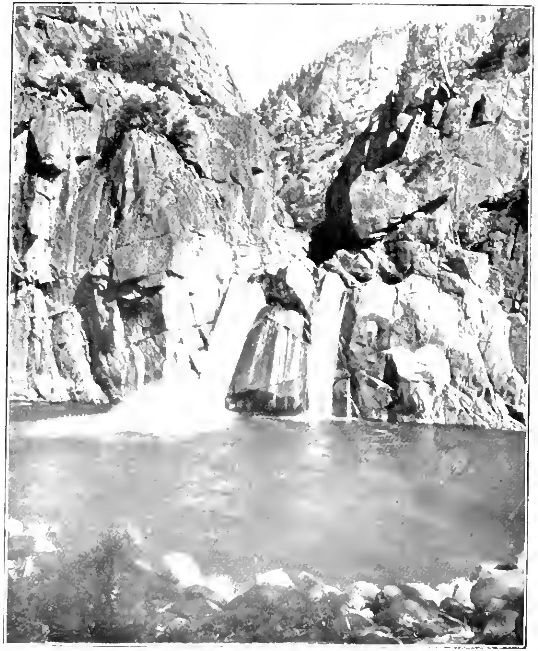
It reproduces itself very persistently, soon taking possession of abandoned or long-neglected ranch land within its range.

Rare or Unimportant Trees.

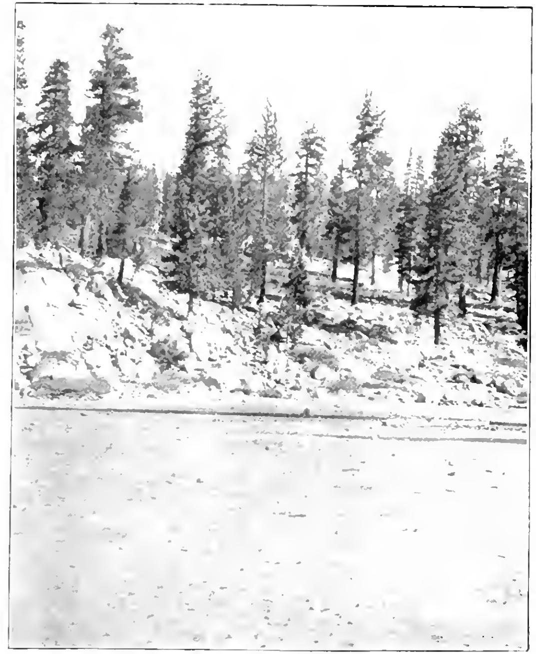
Most of the other sixteen species found in this belt are of such rare occurrence and frequently also of such small size as to deserve only a passing notice. Moreover, the majority are restricted to the courses of streams or the narrow bottoms of dry canyons, and so form but a small part of the general tree growth of the region. The most conspicuous of these species are California white oak and live oak.

CALIFORNIA WHITE OAK.

The California white oak is a tree similar in form to the California rock oak, but is much larger, and is found only in low, rich bottom lands; however, it occurs more extensively to the west of and outside of this region than within it. A number of large trees 2 to 4 feet in diameter were seen on ranches in the vicinity of Green Valley and Shingle Springs, at Pleasant Valley, along the Calaveras River at Jenny Lind, and in the valley of Bear Creek (west side of Bear Mountains). It is said to have been once abundant and to have formed open forests in the above localities; but as it occupied the best agricultural



A. FALLS OF MIDDLE FORK OF STANISLAUS RIVER AT NORTH END OF DONALDS FLAT, STANISLAUS FOREST RESERVE



B. TYPE OF JEFFREY-PINE FOREST, HEADWATERS OF SUMMIT CREEK

lands, it has been very largely cleared off, and is represented now by only a few widely scattered trees, which ranchmen preserve for fuel and shade for stock. Under these conditions there is little reproduction. A few trees of much smaller size, standing far beyond the main range, probably stragglers, were seen also near Garden Valley, Coloma, Lotus, Indian Diggins, Coyoteville, West Point, Glencoe, Railroad Flat, and Sheep Ranch.

CALIFORNIA LIVE OAK.

The live oak also has a greater range westward, outside of this region, but it occurs more or less abundantly in the lower tree belt near the western and southwestern borders. It is confined entirely to ravines, gulches, and creek canyons, and is most common in the region of Bear Mountains, Gopher Ridge, and Bald Mountain. It was seen sparingly on creek canyons from Garden Valley southward to the canyon of the South Fork of American River near Coloma and Lotus. It was seen also on Hangtown and Webber creeks, west of Placerville, but disappeared one-half mile east of the latter place. It likewise appears at Pleasant Valley and southward and in canyons from Indian Diggins westward to Coyoteville and Oleta.

It is always a low, bushy, intricately branched tree from 6 to 18 inches in diameter and 15 to 25 feet high. It prefers dry, gravelly, and rocky soils, and is usually widely scattered.

OTHER SPECIES.

The one other white oak of this region is a rare, inconspicuous shrubby species, 6 to 15 feet high, forming occasional dense thickets somewhat similar to those of the Rocky Mountain scrub oak. It was seen only in the vicinity of Volcanoeville and Georgetown.

Quercus morehus (so-called "black oak") is a very rare species and previously not known to occur in this region. It is reported only from Lake County, California. It is usually associated with live oak. Single trees 20 to 30 feet high and 10 to 14 inches in diameter were seen on a head branch of Canyon Creek (2 miles northeast of Georgetown), on the head of Indian Creek (near Plymouth), on Mokelumne River (west of West Point), several times on Bear Creek Canyon (west side of Bear Mountains), on the head of Murray Creek (2 miles north of Mountain Ranch), and on San Domingo Creek (2 to 3 miles north of Murphy).

MIDDLE BELT.

Abundant and Important Trees.

The trees of this belt form the greater and most valuable part of the forests of the entire region. Five species, the sugar pine, yellow and Jeffrey pine, white fir, and incense cedar, make up the forests of greatest extent, and, with the exception of the rarer and isolated red fir and the giant big-tree, exceed the dimensions of all other trees in the region. In order of abundance the yellow pine ranks first, white fir second, incense cedar third, sugar pine fourth, and Jeffrey pine fifth.

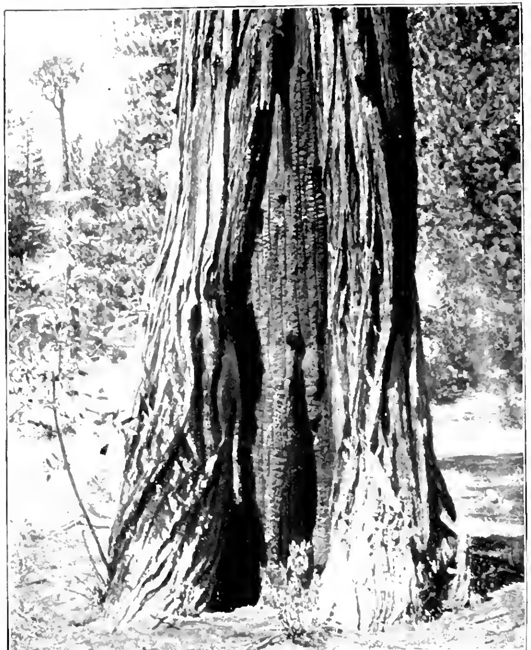
Of equal or of nearly as great commercial importance, but of less common occurrence, are the red fir and big-tree. The big-tree attains the greatest dimensions of all cone bearers in this region, and on this account is the most widely renowned of Sierra forest trees. The red fir ranks in size with the other large timber trees of the territory, but has a limited range here and is the least abundant of this group.

YELLOW PINE.

This species is the most abundant and the second largest pine in the middle belt. The area over which it grows ranges in altitude from 2,000 to 6,000 feet, while the region of greatest abundance and best development lies between 3,000 and 5,000 feet elevation. The relative amount of yellow pine in the average stand varies considerably throughout the altitudinal range of the species and also in different localities at the same level. Large areas, however, especially at the middle and lower levels, often contain 80 to 90 per cent of yellow pine. For the most part, however, there is a larger admixture of incense cedar, white fir, and sugar pine, the yellow pine amounting to from 45 to sometimes 50 per cent.

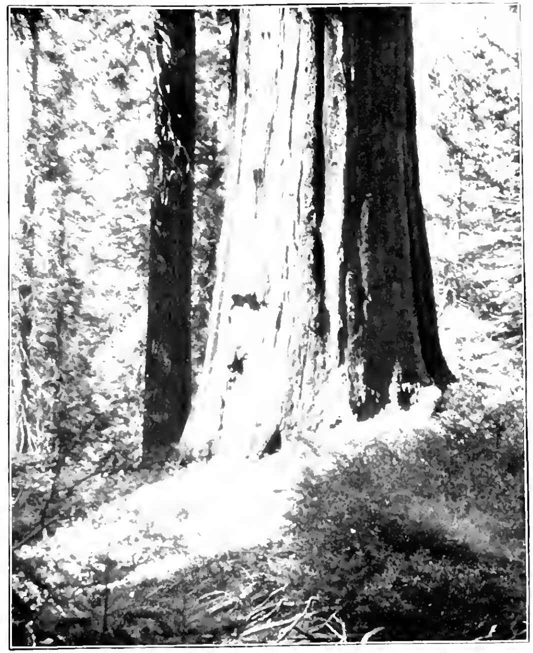
Yellow pine is very adaptive in point of soil and situation. It appears to be most common on southern, eastern, and western slopes, but in some localities is found also on northern slopes. It grows vigorously and attains large dimensions in the poorest gravelly clays or in the crevices of bare, rocky mountain or canyon sides (see Pl. CVI, *B*). The largest and finest timber trees are, however, found growing on rich sandy or gravelly loam benches of from one to several hundred acres in extent on the principal river and lower mountain slopes. Forests of large, mature timber are rarely if ever dense; the single big trees, or groups of three to six trees, stand far apart, forming a characteristically open forest (see Pl. XCII, *B*). Younger forests, 40 to 60 years old, are often very dense, but later these become open by natural thinning, excessive shade, and frequent fires. The common height of yellow pine is from 150 to 180 feet, with a diameter of from 3 to 4 feet; exceptionally large trees are 185 to 190 feet high and 6 to 7 feet in diameter. The maximum age reached is 500 to 520 years, but such trees are rare; the average age is from 250 to 350.

The reproduction of this pine is remarkably persistent and abundant wherever it is not checked by fires and the excessive trampling of grazing herds (see Pls. C, *B*, CI, *B*, and CXII, *B*). The frequent open



A. INCENSE CEDAR (LIBOCEDRUS DECURRENS TORR.) 50 INCHES IN DIAMETER, SHOWING THE EFFECTS OF ANNUAL BURNING

Near Dry Meadow, on headwaters of Soap Creek



B. TRUNK OF BIG TREE (SEQUOIA GIGANTEA), TUOLUMNE BIG-TREE GROVE.

A. YOUNG GROWTH OF YELLOW PINE, WHITE FIR, AND INCENSE CEDAR KILLED BY SURFACE FIRES, NEAR MOUTH OF SOAP CREEK

B. ABUNDANT REPRODUCTION OF YELLOW PINE ON MIDDLE FORK OF STANISLAUS RIVER

spaces in yellow-pine forests are sooner or later covered with dense patches of young trees, but these thickets may in turn be swept off by fire. So continuous and widespread are these forest fires that, except where some natural barrier or chance has prevented, they keep a very large percentage of the seedling growth down. Hence, with the added damage done by other agencies, the general impression is that there is little reproduction of this pine. The forest floor looks clean swept. But the remarkable reproductive power of this pine is seen only in localities where fences and the exclusion of fire have protected the incoming seedlings. Here the stand is so dense as to be quite impenetrable. Cut-over lands thus protected are quickly reclothed with yellow pine. It is believed, therefore, that except in the few localities where this pine has been cleared and kept down the area originally claimed by it is very largely the same as that over which the tree now grows. Necessarily the amount of commercial timber has been greatly reduced on an area formerly well stocked, but the power of this pine to hold its own is unsurpassed by any other associated species.

INCENSE CEDAR.

Incense cedar is an abundant tree in these forests. It is closely associated with the yellow pine, but reaches a higher altitude, occurring at elevations of from 2,000 to 7,000 feet. It is most common between 3,500 and 5,500 feet, where it forms from 20 to 30 per cent of the total stand, while on occasional small areas it may be the prevailing tree. Like the yellow pine, the older growth of incense cedar appears in an equally open stand, having to suffer in common with the pine, and with equal resistance, the thinning effects of fire. While following the pine closely in point of soil and slope, the cedar descends, more often than the pine, into the bottoms of canyons, where it sometimes shares the moist, rocky banks of streams with red fir, alder, and cottonwood.

The trunk form of incense cedar is strongly conical, and appears in marked contrast to the cylindrical boles of the yellow pine. The taper of large cedar trunks ranges from 4 to sometimes 6 inches in 16 feet. The height attained is small compared with the proportionately greater diameter. Mature trees are 80 to 100 feet in height and 4 to 7 feet in diameter. It is a comparatively short-lived tree, as it attains these dimensions in from 100 to 260 years. Old trees are quite generally dead or damaged at the top, and lack the thrifty appearance of younger trees, or even of much older pines and firs on the same ground (see Pls. XCIX, *A*, and CXIII, A).

The reproduction of incense cedar appears to be equal in abundance to that of the yellow pine, especially in the drier situations; but, as already stated, the cedar is far less abundant as a mature forest tree than the pine. This may be accounted for, however, by the fact that being fragile and diseased in middle and old age it succumbs more rapidly than the pine to high winds. Otherwise it is difficult to explain the persistent and abundant reproduction of cedar everywhere visible in the range of the species.

SUGAR PINE.

The sugar pine is quite generally distributed throughout the middle timber belt, but is the least common species of pine over the entire area. There is evidence, however, that formerly it was considerably more abundant than now, and also that it once occupied areas from which it has since nearly or entirely disappeared. Undoubtedly the high commercial value of the timber for certain purposes and the comparatively less prolific reproduction of this pine must largely account for this reduced quantity of the timber and its total disappearance in some localities. The reduction and thinnings referred to took place chiefly along the western border of this timber belt, nearest to the settled districts.

The range of sugar pine in altitude is from 2,000 to 7,000 feet. Only straggling small trees represent the species at the lower elevation, while stunted, scattered trees are found at the higher elevation. The area of greatest abundance and finest growth lies between 3,000 and 5,000 feet. Sugar pine is nowhere common. At most it forms 5 to 20 per cent of the total stand, while in a few exceptionally favorable situations small areas contain 20 to 25 per cent sugar pine. Large stretches of forest possess only occasional trees. Like the white pines, the sugar pine is partial to north slopes and to the protected coves, broad valleys, and mountain benches of southern and western slopes; it is found also on the summits of low mountains. This pine thrives under practically the same soil conditions as the associated yellow pine and incense cedar, but it usually seeks the moister and richer sandy or gravelly loam soils, where the largest and best-grown trees are found. Of all the pines in this region, it is the tallest and attains the greatest diameter. The usual height is from 180 to 200 feet, and in exceptional trees 210 to 218 feet. Diameter measurements range from 4 to 6 feet, or exceptionally from 6½ to 8 feet. The trunks are clear of branches for 60 to 100 feet and are cylindrical (see Pl. XCVI, A). Mature trees are 350 to 400 years old, while the oldest tree found was 515 years.

The reproduction of sugar pine is evident throughout the range of the species. Moderate numbers of seedlings and saplings are always to be found in the vicinity of old trees and are usually mingled with the young growth of other timber trees. There is a marked difference between the persistent, prolific reproduction of yellow pine and the slower, less aggressive advance of the sugar pine. The former readily takes possession of dry, exposed sites, while the latter establishes itself more often on moister, protected places; and when it takes to drier situations, it is usually after the hardier yellow pine and cedar have gained a foothold. Once established, however, the young trees show every ability to hold their own, being rarely crowded out after they attain a height of 6 to 10 feet. They usually soon pass the more numerous yellow pines in height, and remain above them to the end. It is interesting to note, in connection with the limited reproduction of sugar pine, that in addition to the common destruction of seedlings by fires, the paucity of its numbers is due also to a comparatively small seed production. Moreover, there is usually a longer interval (two to three years) between the seed years of sugar pine than between the seeding years of the yellow pine. The latter also produces larger quantities of seed. Besides, the big, rich, nut-like seeds of the sugar pine appear to be eaten more frequently by squirrels than are the smaller yellow-pine seeds.

WHITE FIR.

Two firs, the white fir and California red fir, occur in this timber belt. The former is of greater commercial importance, both on account of its more general distribution with the three preceding species and also on account of the superior quality of the timber. This fir is more or less closely associated with yellow pine, incense cedar, and sugar pine in the eastern part of their range, but does not descend to as low an altitude as these species; as a straggler, however, in the upper timber belt it reaches a higher altitude than any of them. It appears in limited numbers at an elevation of about 3,800 feet and extends up to 7,500 feet. As a timber tree it is common only from about 4,000 feet up to about 5,500 feet elevation. It grows under practically the same conditions as the yellow pine and incense cedar, but is more partial to the situations and soil chosen by the better growth of sugar pine. As a rule, therefore, it is a closer associate of this species than is either of the above trees. It forms from 30 to 45 per cent of the stand over the area of its greatest abundance. On small benches of southern slopes near the lower limit of its range areas may be found where, alternating with those containing an almost pure growth of yellow pine, the stand of white fir amounts to 50 or 60 per cent; the remaining stand is usually yellow pine with a small percentage of incense cedar. The occurrence of so large a percentage of white fir is, however, not general, but rather exceptional, and is mentioned only to show more fully the character of the species.

The trunk form of this fir is cylindrical and straight throughout. The crown is small and narrow, often leaving a clear trunk 40 to 80 feet long, or with only an occasional branch. The common height of mature trees is from 175 to 190 feet; in exceptional cases a height of

200 feet is reached. Diameter measurements range from $3\frac{1}{2}$ to $5\frac{1}{2}$ feet, or very exceptionally 7 feet. Large trees are from 300 to 380 years old.

The reproduction of white fir is very general over the range of the species, and in some sections the young growth is exceedingly abundant. Thickets of seedlings and saplings are often found covering many acres, and to the exclusion of all other species. In locations where other young growth is present the white fir may comprise 40 to 60 per cent of the whole growth. The wonder is that mature trees of this species are not more abundant. But when fires occur, the richly resinous foliage and branches of the young growth suffer more severely than the pines or cedars. Owing to thinness of foliage and less resin, a few of the latter may escape fatal burning; but it is rare that any of a low thicket of firs ever survives even a surface fire. Moreover, the rather small seed production of this fir, and also the long intervals between seed years, has much to do with the frequency at which burned stock is replaced by reseeding.

JEFFREY PINE.

As a commercial tree this pine need not be separated from the yellow pine, as the timber of both is practically the same. Lumbermen and woodmen readily distinguish the two trees, but the lumber of both passes for yellow pine. Without referring to the botanical status of Jeffrey pine as a distinct species or, as some would have it, a variety of yellow pine, the distribution of this tree is interesting. It appears sparingly near the southeastern section of this region at an elevation of 5,000 feet and extends up to 8,500 feet. Between 5,000 and 6,000 feet it is a large timber tree; but above the latter level it is stunted and of little commercial value. From its marked abundance between 6,500 and 8,500 feet this tree appears to belong more properly to the upper timber belt. Its occurrence in the middle belt is little more than straggling, at most constituting not more than 5 per cent of the total stand. It is, moreover, not generally distributed over the middle belt, appearing irregularly and only at wide intervals; while in the upper belt Jeffrey pine is one of the prevailing trees. In its lower range, Jeffrey pine is associated with yellow pine, sugar pine, and white fir on the richer mountain benches, or on the rich borders of mountain meadows (see Pl. XCIII, *A*). In its higher range, Jeffrey pine grows almost entirely in the crevices of granite. It is often much scattered, but is met everywhere, taking the place of the yellow pine in this high, rocky region (see Pl. XCVI, *B*). When not the sole or principal tree it is mixed with western juniper, silver pine, lodgepole pine, and groups of California red fir. But for the bare, soilless surface of these rocky summits, Jeffrey pine would doubtless form forests comparable with those of the yellow pine of lower levels. For wherever in protected hollows or little rocky plateaus disintegrated rock has formed a soil cover, dense stands of Jeffrey pine are always found. The patches of Jeffrey pine seen on the small sandy and gravelly plains among the high mountains to the west and southwest of Lake Tahoe give splendid illustration of this forest-forming tendency in high altitudes wherever sufficient soil is present. As a timber tree, Jeffrey pine reaches a height of 125 to 160 feet or more, with a diameter of 3 to 5 feet. The trunks of these trees are usually straight, cylindrical, and free from branches for 50 to 60 feet. The age of this timber is from 200 to 350 years. Jeffrey pine of the upper tree belt is generally low and stunted, rarely exceeding 40 or 50 feet in height and 2 or 3 feet in diameter. The age of such trees is from 150 to 200 years. Evidently, from the extremely unfavorable conditions under which this tree exists, it is much shorter lived than trees in lower and more protected situations. It suffers considerably from the high winds which sweep over these rocky slopes, as they frequently tear it from its scanty hold in crevices.

The reproduction of Jeffrey pine is observable everywhere in the vicinity of old trees in its lower range, but is nowhere abundant. In higher altitudes, however, seedlings and young trees are frequent. Reference has already been made to the thickets of this pine west and southwest of Lake Tahoe, where the full capabilities of the tree are to be seen. It shows the same vigorous and persistent reproduction in high altitudes that yellow pine exhibits at lower levels.

RED FIR.

On account of its limited range and sparing occurrence in this belt, the red fir is of only secondary importance as a timber tree. Its original range here was probably not much greater than now, but evidently considerable large timber, represented now by young trees, was cut out long ago. The present value of red fir depends entirely on its occurrence with other more abundant timber trees with which it may be profitably lumbered. In has a range in altitude from 2,000 to 5,500 feet. Between 2,000 and 3,000 feet elevation it is inferior in size, widely scattered, and appears chiefly on the steep north slopes of river canyons, while between 3,500 and 5,000 feet it becomes more abundant and is a large timber tree. From 5,000 to 5,500 feet red fir is much reduced in size and only occurs scattered along rocky river and creek canyons from the water's edge up to 500 or 1,000 feet above. The general distribution of this species is exceedingly irregular and there is little or no connection between the areas of growth. Two localities are worthy of special notice, as they include about all the commercial timber found in the entire region. They are located at points 20 to 25 miles northeast and southwest of Placerville. The first area lies to the south and east of Mutton Canyon. The second area lies between Grizzly Flat and Indian Diggins, and is more or less connected by straggling growth with a third small area southeast of Indian Diggins, on Mill Creek (tributary of North Fork of Mokelumne River). These stations are accessible for lumbering the red fir with other timber, while most of the other points at which the species occurs are inaccessible or too remote from pine timber with which it could be lumbered.

Where most abundant, red fir is usually associated with sugar pine, yellow pine, incense cedar, and white fir, in sandy or gravelly loam soils. Here it represents from 2 to 5 per cent of the stand. Areas of one-half to 1 acre may be found, however, where red fir amounts to 40 per cent or more. The trunks of the best trees are straight, free from branches for 50 to 75 feet, but taper quite rapidly from a widely buttressed base. The height is from 150 to 175 feet, and the diameter is from 4 to 7 feet, while the average age is 350 years. The scattered growth of red fir is from 75 to 100 feet high and 2 to 3 feet in diameter, the trunks generally bearing limbs near the ground.

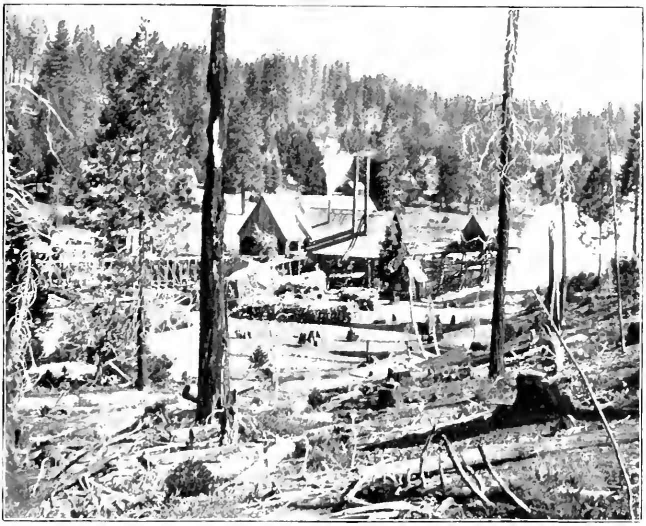
Red fir shows but little reproduction in the region of its best growth, only occasional seedlings or young trees being seen among the greater abundance of pines and cedar. Young growth is much more frequent on the sides of rocky canyons where the old trees are scattered. Red fir, however, does not seed frequently, and the forest trees bear much less seed than the larger crowned trees of the canyon.

BIG TREE (SEQUOIA).

The big tree is the largest conifer found in the middle timber belt, in fact, within the United States. Concerning the general history of this species it may be briefly stated that it grows only on the west slope of the Sierra, and is restricted in its distribution here to eleven more or less isolated groves. These groves extend from the southern border of Placer County southward for a distance of about 260 miles. The elevation of the groves is from 4,600 to 8,400 feet. The northernmost grove is the smallest, consisting of only six trees, while the other groves are much larger, comprising from one thousand to several thousand trees, the southernmost groves being the largest. Most of the groves were discovered between 1841 and 1870. Their exact location, however, and their full extent can hardly be said to be satisfactorily determined even now. Beginning at the north, the names of these groves are as follows:

Big-tree groves in California.

North grove.
Calaveras or "Mammoth" grove.
Stanislaus or "South Calaveras" grove.
Tuolumne grove.
Merced grove.
Mariposa grove.
Fresno grove.
Dinky grove.
Kings River grove.
Kaweah River grove.
Tule River groves



A. SAWMILL NEAR HEADWATERS OF LOVE CREEK

B. EFFECTS OF ANNUAL SURFACE FIRES AND EXCESSIVE GRAZING IN PREVENTING ALL REPRODUCTION HEADWATERS OF JESUS MARIA CREEK

Two of these, the Calaveras and Stanislaus groves, are included in the territory under consideration. The Calaveras grove is situated at the post-office Big Trees and is the smaller grove. The Stanislaus grove, also called "South," or "South Calaveras" grove, is the larger, and is situated about 6 miles southeast of Big Trees, south of the North Fork of the Stanislaus River, and on a high divide between Beaver Creek (on the north) and Griswold Creek (on the south), both tributaries of the above-named river. The elevation of the Calaveras grove is about 4,600 feet, and that of the Stanislaus grove about 5,000 feet. The former occupies 50 acres and contains about 100 trees; while the latter includes about 1,000 acres with 1,380 trees.

Historically these two groves appear to be the most widely known, most of the popular literature extant relating to them. The Calaveras grove is said to have been the first one discovered; but there is considerable doubt as to the exact date, and also as to the name of the discoverer. John Bidwell—afterwards candidate for Congress from California—is credited with discovering the grove in 1841, while a more current story is that a hunter, A. T. Dowd, found the grove in 1852. It is not definitely known when the Stanislaus grove was discovered.

Many of the trees, standing and prostrate, in both groves are named or marked with marble tablets which bear the names of States, distinguished statesmen, generals, scholars, and other people of note. Seventy-five standing trees of the Calaveras grove are named as follows:

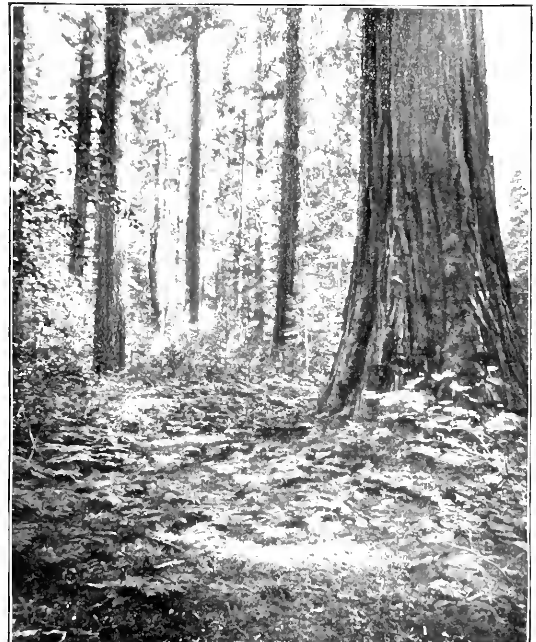
Names of big trees in Calaveras grove, California.

Two Sentinels.
U. S. Grant, named in 1865.
W. T. Sherman, named in 1865.
J. B. McPherson, named in 1865.
Pride of the Forest, once named The Eagle.
Daniel Webster.
Phil Sheridan.
Mother of the Forest.
Three Graces, three trees standing in close line.
Henry Clay.
Andrew Johnson, named in 1865.
Florence Nightingale, once named Nightingale; named in 1865 by a nephew of the English lady.
Bay State.
W. C. Bryant, named in 1865 by a lady, an admirer of the poet.
W. H. Seward.
Pioneer's Cabin, named from the cabin-like chamber and chimney formed by its hollow trunk.
Pluto's Chimney, hollowed out on one side by fire for 90 feet above ground.
Quartette; a cluster of four trees.
America, named in 1865 by a San Francisco lady.
California, once called Ada; named in 1865.
Broderick, once called Mary; named in 1865.

Henry Ward Beecher.
Abraham Lincoln, once called Hermit.
Elihu Burritt.
Uncle Sam.
Alta (Upper) California.
Union.
General Wadsworth.
The Twins.
General Sutter. The trunk divides at 30 feet above ground and forms two trunks.
Salem Witch.
Longfellow.
Prof. Asa Gray.
Dr. John Torrey.
The Trinity; three trees from one trunk, the circumference of which is 60 feet.
Starr King.
Richard Cobden.
John Bright.
Daniel O'Connell.
Edward Everett.
General Scott.
Keystone State.
Sir John Franklin, } Named in 1862 by Lady Franklin.
Dr. Kane, }
Century, named in 1865 in honor of Century Association, of New York, of which the poet Bryant was president.
John LeConte.
Joseph LeConte.
Sequoia Queen, } A cluster of three, the Queen in the center.
Maids of Honor, }
Sir Joseph Hooker, named in honor of the English botanist.
John Lindley, named in honor of the English botanist who was the first to name and describe the big-tree.
Mother and Son; a large and small tree together.
Old Bachelor.
James King of William.
Kentucky.
The Siamese Twins.
Granite State.
The Old Republican.
General Jackson.
Vermont.
Empire State; 94 feet in circumference.
Old Dominion.
George Washington.
Uncle Tom's Cabin.
The Beauty of the Forest.

Several very large trees in this grove have been blown down and one has been cut down; but the wood being of very lasting character, the trunks are still in a fair state of preservation and will remain intact for a long time. These trees are named as follows:

A



B

CALAVERAS BIG-TREE GROVE

Names of big trees blown down in Calaveras grove, California.

Father of the Forest, cut down in 1853.
Miner's Cabin, blown down in 1860.
Fallen Monarch, fell probably fifty or more years ago.

Twenty-five standing trees in the Stanislaus grove are named as follows:

Names of big trees in Stanislaus grove, California.

Columbus.
New York.
Correspondent
Fred.
Electra.
Ohio.
Grand Hotel.
Smith's Cabin.
General Custer.
Sir Francis Hucks.
Dr. J. W. Dawson.
Two Lovers.
Massachusetts.
General Garfield.
Hancock.
Grover Cleveland.
Mrs. Grover Cleveland.
Cyclops.
Palace Hotel.
Knight of the Forest.
The Three Graces.
Noah's Ark.

The notable fallen tree of this grove is Old Goliath.

The big tree is always associated with yellow pine, sugar pine, white fir, and incense cedar, but more commonly with sugar pine and white fir. Clusters of two to four trees are frequent, and often several of these are found in close proximity, but in general the big tree is much more scattered, and forms from 1 to 3 per cent of the total stand. The forests in which it occurs are somewhat denser than elsewhere in the middle timber belt, a fact which is accounted for by the exceptionally rich, deep soil and the protected sites where the big tree grows (see Pl. CII, *A* and *B*). Conditions elsewhere similar to these are conducive to the greatest density of the same pines and fir, which are here associated with the big trees.

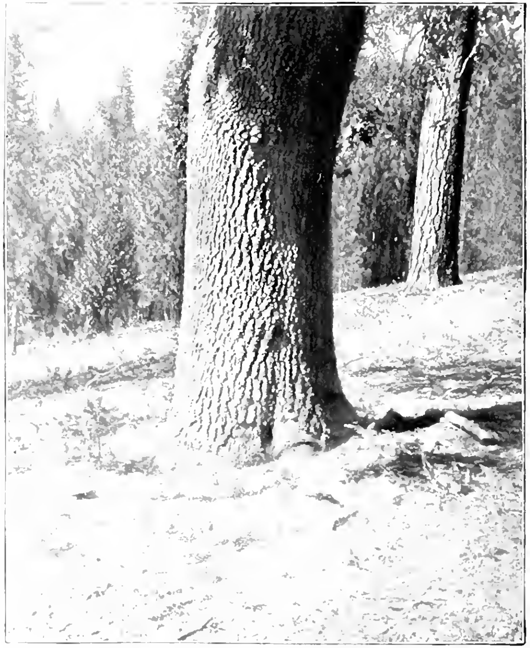
The big tree of these groves grows on northern, southern, and western slopes of gentle incline, and also in the inclosed broad shallow valleys. The soil is a deep, rich, sandy loam, with considerable humus on the lower levels of the tracts. Toward the outskirts of the groves, especially on higher ground, the soil grows poorer and drier, and the big trees grow scarcer, while yellow pine and incense cedar become more common. Frequent fires and extensive grazing in the Stanislaus grove have reduced, and in some parts destroyed, the naturally thick ground cover of underbrush and herbaceous plants. In the Calaveras grove, however, the protection from fire and the exclusion of grazing during the last thirty or forty years have preserved in this forest the most perfect ground cover of low woody and herbaceous plants (see Pl. CII). As a result, the top layers of deep humus and earth are moderately moist, even in the driest months; while 100 yards outside, where fires are frequent and the forest land is overgrazed, there is no humus and the soil is dry and dusty. The forest conditions of these two tracts are therefore markedly different. The Calaveras tract represents, through its long protection, probably the only bit of strictly virgin forest anywhere in the Sierra. The Stanislaus tract approaches nearest to these conditions of any other body of forest in the region examined. The vigorous undergrowth which persists in parts of this forest, even under the trying conditions of an open stock range, is due almost entirely to the small but continuous flow of water during the dry season. It is evident, therefore, that had this grove been rigidly protected the luxuriousness of its forest growth would have far surpassed that seen at present in the Calaveras grove.

The trunk of the big tree has an enormous swell at the ground. This swell is 2 to 8 feet greater than the diameter at 6 feet from the ground. The trunk above the swell is also rather strongly conical, often showing a decrease in diameter of from 6 to 12 inches or more in every 16 feet. The length of clear pole varies from 100 to 180 feet; occasionally two or three branches may be scattered over this length.

As might be expected, the Calaveras grove big trees are less damaged by fire or wind, or other agencies than those in the Stanislaus forest. Only a few of the former bear fire marks, which do not, however, disfigure the trees badly. The damage from fire occurred many years ago. The largest tree in the grove is dead, but still standing. The bark was stripped off in the early fifties to a height of about 116 feet, and sent to England for exhibition purposes. The peeled trunk appears to be perfectly sound throughout.

A greater number of the Stanislaus grove big trees bear fire marks than do those of the Calaveras grove. The damage is also greater and more conspicuous; in one or two trees the fire has hollowed out immense cavities. Moreover, considerable burning has taken place in recent years.

The following table of measurements shows the range of height and diameter growth for trees in the Calaveras grove, and will also serve to illustrate the dimensions of trees in the Stanislaus grove. The trees of the two groves are altogether quite similar in size and appearance.



A. CALIFORNIA BLACK OAK (QUERCUS CALIFORNICA (TORR.) COOPER).

B. BEST DEVELOPMENT AND MAXIMUM DENSITY OF A MIXED FOREST.

A. BAND OF SHEEP IN YELLOW-PINE FOREST NEAR SOUTH FORK OF MOKELUMNE RIVER

B. SHAKE-MAKER'S CABIN.

Table showing diameter and height of big trees in the Calaveras grove.

Tree No. —	Diameter 6 feet above ground.	Height.	Tree No. —	Diameter 6 feet above ground.	Height.	Tree No. —	Diameter 6 feet above ground.	Height.
	Feet.	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*
1	9.0	235	11	12.5	250	21	15.0	325
2	9.0	251	12	12.5	266	22	15.5	268
3	9.5	260	13	13.0	286	23	15.5	272
4	10.0	237	14	13.5	320	24	15.5	289
5	10.0	243	15	14.0	259	25	16.0	262
6	10.0	261	16	14.0	265	26	16.0	275
7	10.5	248	17	14.0	269	27	16.5	266
8	11.0	255	18	14.5	278	28	16.5	268
9	11.0	260	19	15.0	285	29	16.5	288
10	12.0	248	20	15.0	307	30	19.5	315

It is at present very difficult to determine the age of big trees in these groves. With the exception of a weather-beaten section of the tree cut down in the Calaveras grove in 1853, there is no available material on which to base age determinations. The diameter of the stump of this tree measured 27 feet inside the bark and the age of the tree is about 1,300 years. Mr. John Muir states that a tree of similar diameter cut down in the Kings River grove was 2,200 years old. He also mentions another tree of the same grove as being 4,000 years old, and probably older, as all the rings could not be clearly counted. Probably none of the Calaveras or Stanislaus grove trees are older than this, and most likely the majority are under 2,500.

The big tree is not being reproduced at all in the Calaveras grove, and at only two points in the Stanislaus forest. Here the young growth occurs in small, dense patches covering about one-fourth of an acre. The seedlings are from 2 inches to 4 feet high, and the saplings are from 10 to 30 feet high. They have sprung up in open places almost completely shaded by old big trees, sugar pines, and white firs. The soil has a deep humus and is constantly and thoroughly moist. A barrier of fallen timber has doubtless for a number of years prevented the large herds of cattle which roam this forest from trampling the younger seedlings to death. All the young trees are vigorous and growing rapidly.

The drier soil conditions of the Calaveras grove account for the lack of recent reproduction. Judging from the large amount of soil moisture attending reproduction in the Stanislaus grove, it is perfectly evident that the soil of the Calaveras grove is too dry to stimulate germination; otherwise, young trees would be found. The production of seed appears to be abundant, and 30 to 40 per cent of the seed examined was good. There has probably been no reproduction in this grove for at least forty or fifty years, for the smallest trees found are now 18 to 24 inches in diameter.

CALIFORNIA BLACK OAK.

Of the remaining sixteen trees found in the middle timber belt, the California black oak is the only one deserving special notice. This is, however, entirely on account of its large size and frequent occurrence. Its poor form and inferior wood make it a tree of no economic value. It is more conspicuous as an associate of yellow pine and incense cedar than any of the other large trees. The altitudinal range is from 1,500 to 6,500 feet, while it occurs most commonly and of largest size between elevations of 3,500 and 4,500 feet. At the lower and higher elevations mentioned this oak is usually rare and of small size. In its middle range it forms 5 to 10 per cent of the total stand. In many localities, however, small areas may be found where this tree constitutes one-half or more of the forest growth. Such areas are frequent on dry, rocky benches of the southern and western slopes of river canyons, and also on the gravelly summits of the low mountains within the yellow-pine belt.

In its greatest abundance the California black oak occurs only in an open stand, and being of short stature its presence is lost sight of in general views of the prevailing coniferous growth. It is conspicuous only in a careful examination of the forest. The usual height is from 40 to 50 and exceptionally 70 feet. The diameter ranges from 1 to 2½ feet, while occasional old trees are 3 to 4 feet in diameter (see Pl. CIII). Large trees are 150 to 200 years old. The trunks are uniformly short and very crooked; the crowns are broad and composed of a few large sprawling limbs. The wood being brittle, the tops of the trees are frequently broken by winds, and as a result the trunks of the majority of old trees are hollow or decayed. Many of these are blown down or broken off.

The reproduction of this species is very persistent and abundant throughout its range. Frequent surface fires damage or kill the seedlings down to the ground, but rarely injure the strong deep roots, which sprout vigorously from year to year, until one shoot grows large enough to survive burning. The hard, thick bark of even young trees endures considerable scorching without damage to the tree.

Rare or Unimportant Trees.

The remaining trees of the middle timber belt are comparatively rare, being confined in their range either to the bottoms of canyons or to other similarly restricted localities. With few exceptions, they are of small size, and few are of economic value. Together, however,

A. REPRODUCTION OF CALIFORNIA RED FIR (ABIES MAGNIFICA MURR.)

Gravelly mountain summits, near headwaters of Blue Creek.

B. SUBALPINE LAKE AND MARSHY MEADOW.

they form a low protective forest cover, chiefly broadleaf in character, in localities where conifers are least abundant. Brief notes are given for the more conspicuous or otherwise notable species.

CANYON LIVE OAK.

The canyon live oak is the largest of these trees, and the most widely distributed. It is scattered through all canyons from 1,500 to 6,000 feet elevation, and occasionally ascends low mountain ridges and spreads over high, broad valleys. The largest trees occur between about 3,000 and 5,000 feet elevation. It is a low, broad-crowned tree with huge branches extending from a trunk 4 to 8 feet in length. The trunks are 1 foot to sometimes 4 feet in diameter.

OREGON MAPLE.

The Oregon maple is the next most widely distributed species, and the only one of its kind in the middle belt. It is mostly a low, very crooked tree, occurring sparingly near streams or in the bottoms of canyons, at elevations between 2,000 and 4,500 feet. Occasionally it forms the principal tree growth for short distances along small streams. The short crooked trunks are 8 to 20 inches in diameter.

PACIFIC DOGWOOD.

Pacific dogwood is a small tree, sparsely but generally distributed between elevations of 3,000 and 5,000 feet. It is partial to deep shade and moist soils in the vicinity of small streams and coves. The common size is 10 to 20 feet high and 2 to 8 inches in diameter.

BLACK COTTONWOOD.

Black cottonwood grows along streams, or less commonly near the shores of large lakes. It appears rather abundantly at several points in the bottoms of the larger river canyons. The growth is rarely continuous for any considerable distance, but more often groups or small patches of trees are widely scattered. Its range in altitude is from 3,000 to 6,500 feet. Where most abundant the trees form dense patches down to the water's edge, to the exclusion of other trees. Here the trunks are straight and clear of branches for 15 to 20 feet. The largest trees are 25 to 35 feet high and 10 to 24 inches in diameter.

WHITE ALDER.

White alder is nowhere abundant, but frequent on streams between elevations of 2,000 and 5,000 feet. In a few instances it descends on small streams to 1,000 feet. It usually grows close to the water and in a more or less continuous fringe for a considerable distance. It is especially at home in a wet soil, and occasionally quarter-acre patches of pure growth occur in wet boggy creek bottoms. The trees are 25 to 30 feet high and 6 to 20 inches in diameter. The trunks are short, straight, and much branched, somewhat resembling a beech.

MADROÑA.

The main range of the madroña lies in the coast region of California and northward, and so far as known to me this tree has never been reported from any locality in California as far east as the Sierras. The madroña occurs rather abundantly in a few localities in the middle timber belt at elevations of from about 2,500 to 4,000 feet. It occurs in the moist soil of shady coves, on small streams, or in dry, clayey and gravelly soils of low slopes, here mingled with yellow pine. Almost pure growths of several acres' extent occur on low slopes and in bottoms. It was found in greatest abundance on the headwaters of Sutter, Pioneer, Mill, and Jesus Maria creeks. It was found also, but less abundantly, on Empire Creek, between Garden Valley and Georgetown, and on Otter Creek (tributary to Middle Fork of American River). Large trees are crooked and scraggy, ranging in height from 30 to 40 feet, and in diameter from 12 to 20 inches. It forms a dense shade in pure growth, and appears to spread and hold its own in the densest thickets of yellow pine. It sprouts vigorously from stumps when cut, and also from the roots when the trees are burned to the ground.

TAN-BARK OAK.

The range of this tree appears to be limited. Although occurring rather abundantly where discovered, it was found in only a few localities at altitudes ranging from 3,000 to 5,000 feet. These are on the west slope of Tunnel Hill, on the headwaters of Otter Creek, on Pilot Creek, in the vicinity of Deep Canyon and Mutton Canyon; also in Big Iowa Canyon (tributary to South Fork of American River). It grows in dry sandy and gravelly soils on exposed slopes, and frequently in deep, shady coves and canyons. Rarely more than two or three trees occur together. It is a low, much-branched tree, the trunk dividing near the ground into large branches. The height is under 30 feet, and the diameter is from 6 to 18 inches.

The low, bushy variety of this species (*Q. densiflora* var. *echinoides*) forms thickets on the north slope of Rubicon River Canyon at 4,000 to 4,500 feet elevation.

CALIFORNIA SCRUB OAK.

The California scrub oak completes the list of oaks found in this belt. It is a slender, shrubby species, 6 to 15 feet high, forming small thickets near the bottoms of canyons. It was seen at elevations of 2,500 to 3,000 feet on the headwaters of Esperanza Creek (tributary

A. FOREST FIRE SET BY LUMBERMEN TO BURN OUT A "JAM" OF TOPS

B. INTERIOR OF YELLOW-PINE FOREST ON SANDY BENCH LAND

to North Fork of Calaveras River) and on San Antonio and Indian Creek (tributaries to South Fork of Calaveras River).

SHORT-FLOWER MAHOGANY.

The short-flower mahogany is a rare shrubby tree seen only on the south slope of Indian Creek Canyon, near the headwaters, at 3,000 feet elevation.

COFFEE BERRY.

The coffee berry (*Cascara sagrada*) is a rather common shrub, 4 to 6 feet high, and occasionally occurs as a slender tree 10 to 20 feet high on dry, gravelly, and rocky slopes and summits, at elevations from 1,500 to 6,000 feet. It is most abundant between 2,500 and 4,000 feet elevation, and is a frequent associate of the shrubby manzanita.

WESTERN CHOKECHERRY.

The western chokecherry is a rare, slender tree seen in the canyon of the South Fork of American River at an elevation of 4,000 feet and also on the north slope of Mokelumne River at 2,500 feet elevation.

PACIFIC PLUM.

The Pacific plum is also a rare tree of shrubby habit, forming small thickets on dry slopes of canyons at elevations of 3,000 to 4,000 feet. It was seen on the headwaters of Camp Creek (tributary of North Fork of Cosumnes River) and at the head of Pioneer Creek (tributary of Sutter Creek).

CALIFORNIA TORREYA.

This species is exceedingly rare, if it is not the rarest in the region. Only 16 trees were seen. These were in the canyons of the following streams: Empire Creek (tributary of South Fork of American River) at 2,500 feet elevation; north slope of South Fork of Mokelumne River at 2,000 to 2,500 feet elevation; San Antonio Creek (tributary of South Fork of Calaveras River) at 2,000 feet elevation, and on South Fork of Webber Creek at 3,000 feet elevation. They are small, straight trees, 10 to 30 feet high, with branches down to the ground, and thrive in the densest shade of yellow pine, cedar, and red fir. A few seedlings were found near one group of trees only. The reproduction of this species is apparently very limited, owing to the fact that being diœcious only a part of the trees bear fruit; and this, too, is produced sparingly.

PACIFIC YEW.

The Pacific yew is also comparatively rare and isolated. It occurs in the deepest shade of red fir, white fir, and incense cedar, in moist soil along small streams, and in ravines and narrow coves. Only a few trees occur in each locality, and these are commonly low and widely branched to the ground. The height is from 10 to 20 feet and the diameter is from 6 to 10 inches. Moderate reproduction was seen near groups of these trees. The localities in which this species was found are as follows: Vicinity of Mutton Canyon and Deep Canyon (branches of Pilot Creek, a tributary of Rubicon River) at 4,000 feet elevation; Big Iowa Canyon (tributary of South Fork of American River) at 3,000 feet; headwaters of Sly Park Creek (tributary of North Fork of Cosumnes River) and North Fork of Webber Creek, at 4,000 feet; at 2,500 to 3,000 feet on the headwaters of Cedar Creek (tributary same river); at 3,500 feet on Clear Creek (tributary of Webber Creek); headwaters of Mill Creek (tributary of North Fork of Mokelumne River) at 3,500 to 4,000 feet elevation.

Shrubs.

Besides the trees of this timber belt, there are several large shrubs, of which the manzanita (*Arctostaphylos pungens*) is the most conspicuous. It is widely distributed on all dry gravelly slopes at elevations of from 1,500 to 6,000 feet. It grows abundantly in open places among yellow pines, and quickly takes possession of exposed slopes wherever patches of forest have been cut or burned off. Here its stiff harsh stems form almost impenetrable thickets from 6 to 10 feet high. Surface fires repeatedly kill the growth down to the ground, but the roots sprout vigorously and continue to maintain a strong protective cover, which is important on steep slopes. In localities where the ground is not too constantly burned over this chaparral does not exclude the final but slow recovery of the land by conifers.

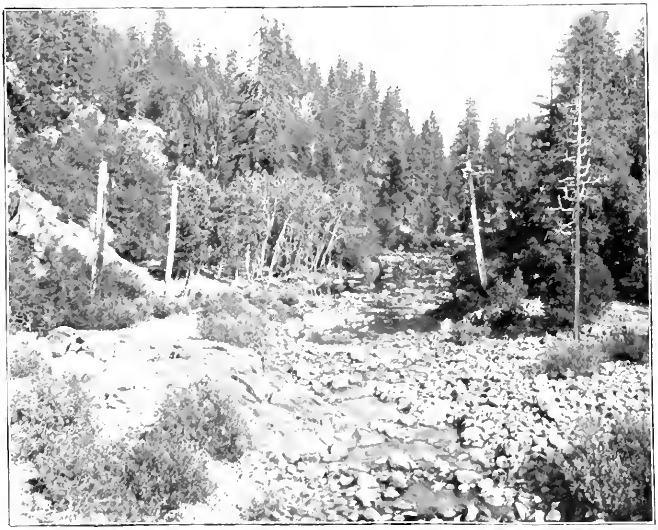
UPPER BELT.

Abundant and Important Trees.

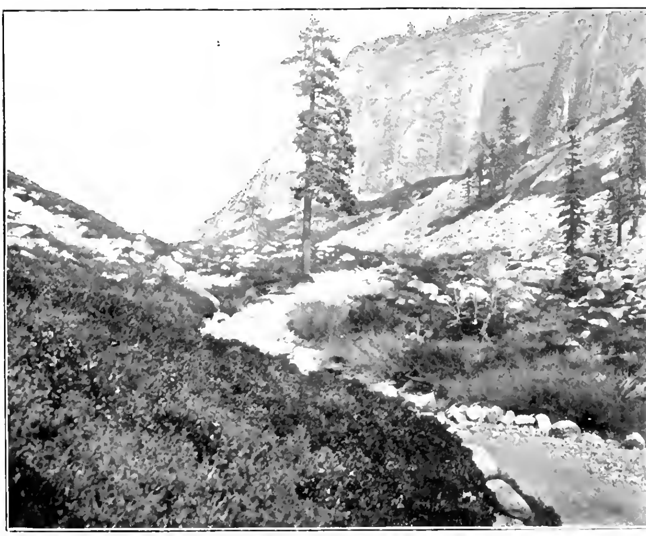
The major part of this belt is made up of three conifers—the lodgepole pine, Jeffrey pine, and California red fir. The white fir is more or less frequent at the lower limit of the belt, but even here must be regarded as a straggler from below. The other conifers and broadleaf trees of the belt form no considerable part of the forests. Altogether the commercial importance of this forest is small, except at the lower limit, where most of the large timber is found and where also this timber is most easily accessible.

LODGEPOLE PINE.

This pine is widely distributed between elevations of 6,000 and 9,300 feet, while the area of greatest abundance lies between 6,000 and 8,500 feet. A few trees, however, were discovered at elevations of 3,500, 4,000, and 5,000 feet. These stations are far distant and in no way connected with the wider range of the species, and must, therefore, be considered mere outposts. The lodgepole pine occurs most



A. SOUTH FORK OF AMERICAN RIVER NEAR BULLION BEND.



B. CANYON OF SOUTH FORK OF AMERICAN RIVER

abundantly in pure growth on the margins of mountain meadows. On higher ground it is associated more or less with Jeffrey pine, California red fir, western white pine, and occasionally with black hemlock, here forming 50 per cent of the stand. The forests of pure growth are rather dense (100–150 trees to the acre), but in mixture on higher, rocky, broken ground the stand is open and often scattered (40 to 50 trees per acre). This tree shows a remarkable adaptation to widely different soil conditions and site. It thrives best in the meadow bottoms, but spreads persistently over low rocky ridges and stretches of high granite plateaus, establishing itself everywhere in crevices and pockets. The trunk form is poor, though moderately cylindrical, and is altogether much inferior to that produced in the Rocky Mountain range of this species. Except in patches of the densest stand, the trunks bear large limbs down to the ground. The height is from 30 to 80 feet, with diameters ranging from 11 to 39 inches; diameters from 11 to 24 inches are most common. On the high, wind-swept sites at the upper limits of distribution the trunk becomes very short, in fact the form is reduced to a sprawling shrub under 2 feet in height. The age of the largest trees is from 100 to 150 years.

The reproduction of lodgepole pine is everywhere abundant and most persistent. Dense thickets of young trees and seedlings are common wherever there is soil, and are always present in crevices and pockets where the tree occurs on granite. Patches of fire-killed timber are replaced in a few years by reseeding from cones on the dead trees, the cones being rarely destroyed by surface fires. A notable difference between the Sierra and Rocky Mountain form of this tree is that cones of the former usually open and shed their seed during the same year they mature. Mature cones of the Rocky Mountain lodgepole pine are likely to remain closed for several seasons before opening.

CALIFORNIA RED FIR.

The California red fir is one of the three conspicuous trees in the upper timber belt, and is also the fir most commonly met with. Although generally distributed, the bulk of this timber occurs in forests more or less separate from those of lodgepole and Jeffrey pine. The altitudinal range is between 6,000 and 8,500 feet, and the prevailing growth lies between 6,500 and 7,500 feet. Its occurrence at levels between 5,000 and 6,000 feet is straggling. Forests of pure growth are frequent on the soil-covered lava-rock benches on the eastern, southern, and western slopes of the larger mountain peaks and ranges. Interspersed with such areas are those with a mixed forest of lodgepole pine, Jeffrey pine, silver pine, and black hemlock, in which the California red fir forms 40 to 50 per cent of the stand. The forests of pure growth are usually of considerable extent and uniformly so dense as to exclude all undershrubs. In this respect these fir forests are exceptional for the entire territory, as no other timber tree produces so dense a stand. The mixed growths are more open.

The trunk form of this species at the lower levels of its range is cylindrical, and the shafts are remarkably straight and clear of branches for 40 to 60 feet or more. At the middle and upper levels of distribution the trunks are very conical, short, and invariably strongly curved at the base. This curve in the trunk is traceable, however, to the annual bending of young seedlings to the ground by heavy falls of snow. After the snow is gone, the young trees are partially straightened up by each season's upward growth, but the wide curve in the stem is retained and becomes a marked feature in the mature trunk. The height of this fir is from 80 to 175 feet, with diameters ranging from 12 to 60 inches. In the area of greatest abundance the common sizes are 100 to 140 feet in height and 24 to 40 inches in diameter. The largest dimensions are attained by scattered trees at the lowest limit of distribution, while the smallest trees are found at the upper limit. The age of mature trees is from 250 to 300 years.

The reproduction of this fir is exceedingly abundant. The smallest openings made in high fir forests is promptly filled by seedlings. The shade endurance of seedlings under such conditions is very great. Frequently they remain suppressed for 10 to 20 years and are no more than 2 or 3 feet high. The remarkable capacity of California red fir for re-covering large denuded areas is seen where fire and excessive grazing have left the gravelly soil bare and dusty. Here, if by accident those spots are undisturbed for several years, this fir springs up in the closest possible stand, and the young trees grow rapidly, reaching a height of 8 to 10 feet in five to seven years. Their thrifty, vigorous appearance is striking (see Pl. XCV, *B*). Comparatively speaking, this fir is reproduced more plentifully than the white fir. The reasons for this appear to be three—greater seed production, more soil moisture, which alone insures full germination of the seed, and less destruction by fire. There is one other advantage which this fir has over the white fir. A smaller percentage of California red-fir seed is eaten by rodents than of white-fir seed, a fact which is accounted for because these animals are far more abundant in the yellow-pine belt, where the white fir abounds, than in the higher range of the California red fir.

JEFFREY PINE.

This pine has been fully discussed as a tree of limited occurrence in the middle timber belt, where the small production of useful timber gives the tree its only commercial importance.

WHITE FIR.

The white fir, which is fully described as a principal species of the middle or yellow-pine timber belt, is mentioned in the present connec-

A. CASCADE LAKE LOOKING SOUTHWEST FROM NORTH END OF LAKE.

B. WEST SLOPE OF RUBICON RIVER CANYON

tion only as a species irregular in its extension into the upper timber belt. It occurs here very sparingly and is usually associated only with California red fir. There appears to be great irregularity in the extension of this fir into the upper belt, the extension consisting in isolated trees or small groups.

Rare or Unimportant Trees.

WESTERN WHITE PINE.

Western white pine is rather rare but widely distributed between 6,500 and 9,400 feet elevation, being most frequent between 7,000 and 8,500 feet. It appears as scattered individuals, or at most several trees together, associated with California red fir and black hemlock, or less frequently with lodgepole pine. In rare instances small areas of mixed forest may contain 5 to 15 per cent. On very rocky exposed high slopes it is sometimes conspicuous in being about the only straggling tree. The trees are gnarled and twisted in such locations, becoming greatly stunted at the extreme upper limit of distribution. The trees found in the mixed forests of lower levels are generally of good timber form, the trunks being straight, cylindrical, and clear of branches for 30 or 40 feet. The height of such trees is from 100 to 140 feet and the diameter is from 15 to 40 inches. Isolated trees on high exposed slopes are rarely over 50 feet in height, but frequently 30 to 50 inches in diameter, the limbs on these trees extending nearly to the ground. Mature trees are 160 to 225 years old.

Very little reproduction of the species was observed, although both the forest grown and other trees bear seed plentifully. Only a few scattered seedlings, from 6 inches to 3 feet high, are found near trees in the mixed forests, and still more rarely are seedlings found about trees in the open. The sparse reproduction of this pine is in marked contrast with that of the prolific lodgepole and Jeffrey pines, and indicates the much smaller capacity of this tree to multiply even under apparently favorable conditions.

But for the very limited supply of this timber, its excellent quality in mixed forests would give the species great commercial importance as a timber tree.

BLACK HEMLOCK.

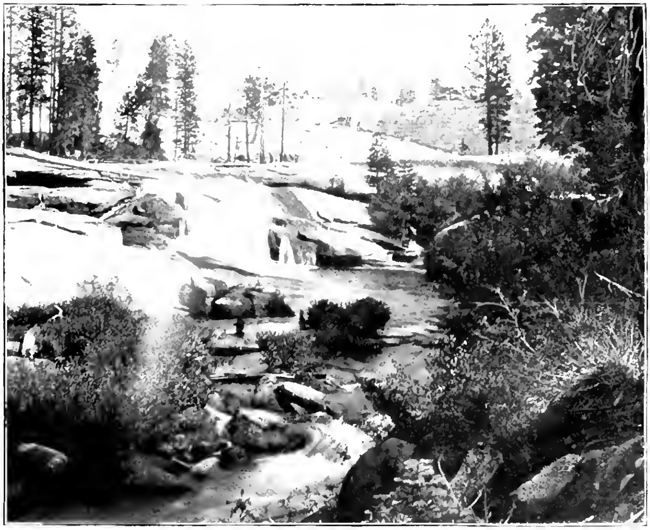
Black hemlock is a strictly subalpine tree, confined chiefly to northern slopes at elevations between 6,900 and 9,400 feet. It is generally distributed within these limits and associated often with lodgepole pine only, or with western white pine, lodgepole pine, and California red fir; while in its highest range it occurs in small patches by itself, interspersed with those of white-bark pine. The mixed growths of lower levels are usually low, rather thin forests, entirely protective in character, largely on bare, broken lava rock or granite. Mixed with lodgepole pine it grows also on the mucky borders of subalpine meadows and lakes (see Pl. CV, *B*). Black hemlock is most abundant between 7,000 and 8,500 feet elevation. Within this area the hemlock sometimes forms from 10 to 25 per cent of the total stand. At the highest and lowest limits of distribution the occurrence of this species is irregular and at wide intervals. The common trunk form is rather strongly conical and the stem bears branches quite to the ground. A few of the larger trees in protected gulches or on benches are fairly cylindrical, and the trunks are clear of branches for 20 feet to 30 feet. The trunks are never quite straight, being slightly curved. The height is from 25 to 90 feet, the prevailing height being 30 to 50 feet. Diameter measurements are from 12 to 32 inches, but the latter dimension is rather rare. The age of low timber in open forests on rocky sites is from 80 to 150 years, and that of larger trees in denser growth in protected localities is from 160 to 190 years. The largest trees of the open, exposed forests are often uprooted by high winds, a fact which may account for the general absence of old trees in this type of forest, while large trees in protected localities are less commonly destroyed by storms.

Black hemlock is reproduced plentifully throughout the major part of its distribution, the extreme upper limits of range being the exception to this, here showing only occasional reproduction. Numerous small seedlings and patches of young trees 3 to 10 feet high are present everywhere among the older trees. The old and even half-grown trees bear large crops of cones which yield an abundance of seed, and the high range of the tree on northern slopes usually insures to the fallen seed more prolonged moisture conditions than are available to species prevailing on the dryer southern, eastern, and western slopes.

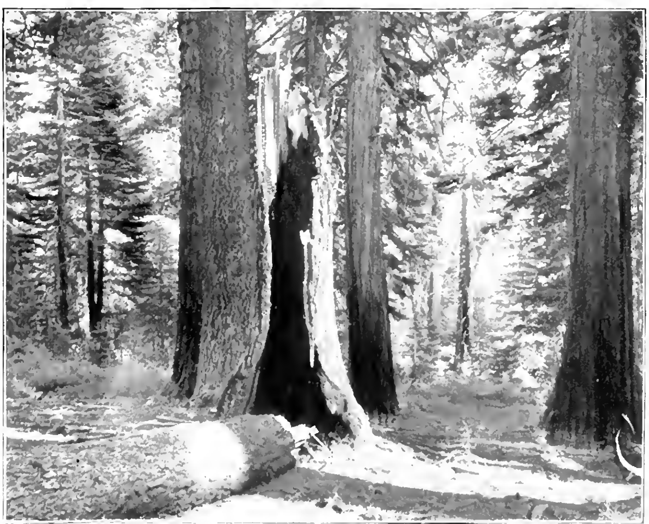
The black hemlock has no commercial value, but is an important concomitant of protective forests on and near the extreme headwaters of the larger streams or their tributaries.

WESTERN JUNIPER.

This is a tree of high altitudes and of exposed situations. It is nowhere abundant, but is frequent as a scattered tree on bare granite-rock slopes and low summits between 7,000 and 8,500 feet elevation. On some of the mountain ranges it is more common on southern than on other slopes, yet elsewhere it is found on eastern and western exposures also. The western juniper never forms a close stand. Single trees, or clumps of two or three trees very close together, occur at rather wide intervals, at most not averaging more than three trees to the acre (see Pls. XCVI, *B*, and XCVII, *B*). Its principal associate is the similarly scattered Jeffrey pine. In the more exposed situations the trees are low and of disproportionately large diameter. The tops are frequently broken by storms, but the trees are so strongly rooted in the crevices of rock that few are ever uprooted. Occasional protected gulches have much taller and better proportioned trees. The



A. LITTLE SOUTH GERLÉ CREEK AT WEST END OF LOON LAKE



B. SUGAR PINE 4 FEET IN DIAMETER FELLED BY PERSISTENT BURNING

height growth is from 20 to 30 feet, and in rare instances 35 to 40 feet, with diameters from 2 to 4 feet. The trunks are very irregular in form, usually having prominent broad ridges and being widely buttressed at the base. Stout branches are borne nearly down to the ground, leaving little or no clear trunk.

The reproduction of this juniper is sparing, but young trees and seedlings are nearly always to be found in numbers quite proportionate to the stand of mature trees. There is evidence in this and in the profusion of berries borne that this species holds its own. It is a tree of no economic importance, however, and because of its scattered growth contributes very little to the protective forest cover of the high mountains.

WHITE-BARK PINE.

This pine has the most limited range in altitude of any conifer in the upper timber belt, but reaches a higher elevation than any other tree within these limits. It grows among broken bare rocks and in beds of disintegrated granite at elevations between 8,000 and 9,500 feet, forming small patches of stunted and storm-beaten trees with which, except at the upper levels, are interspersed groups and single trees of black hemlock, Western white pine and lodgepole pine. At the upper limits of its distribution the white-bark pine is the only tree and is the one which fixes the timber line for this belt. White-bark pine grows on eastern, southern, and western slopes only, showing no tendency to establish itself on contiguous northern slopes, even at points where descent to such locations would seem natural.

The largest trees occur at the lowest levels of distribution, while successively smaller trees are met as higher levels are reached. The form of this species found at and near timber line is represented by a sprawling mat of branches lying flat on the rocks; the branches often grow to great length from a trunk less than a foot high. Trees of greater height can not withstand the terrific winds which sweep over these high, bare slopes and summits.

The trunks of this pine are, for the most part, crooked and twisted or gnarled. Occasional trees on the lower levels are straight, but these still show in their conical trunks the effects of exposure to heavy winds. The usual height of the largest trees is from 8 to 20 feet, with diameters from 14 to 24 inches. While these short, sturdy trees generally withstand the fierce winds and the falling and sliding of tons of snow and ice, many trunks are uprooted or torn asunder.

The reproduction of white-bark pine is rather scanty. A few stunted seedlings and young trees can be found near the patches of old trees; but more often seedlings take root under the low protecting branches of the old trees. Those beyond this shelter are so constantly and violently swayed by wind that many of the stems are gradually ground off by rubbing against sharp particles of rock. It is evident from this difficulty in spreading, that the existing patches of this pine have been established after a hard struggle. Most of the reproduction being within these groups, the latter long remain narrowly circumscribed.

OTHER SPECIES.

The remaining trees of the upper belt are so insignificant in size as to deserve only passing notice. All are practically shrubs, forming low, tangled thickets along small streams on the borders of moist meadows, or on the lower edges of timber belts occupying steep slopes. In this they are useful adjuncts to the general protective forest cover of high altitudes.

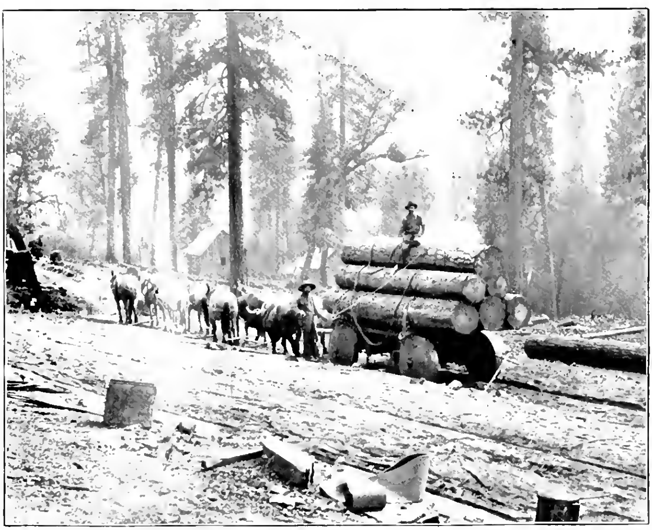
The smallest and the least abundant of these species is the dwarf maple found at altitudes between 5,000 and 7,500 feet, and mainly between 6,500 and 7,500 feet. Its slender stems are 2 to 10 feet high, and almost prostrate from the weight of heavy snows. The aspen is rather widely distributed at elevations between 6,500 and 8,500 feet, only occasional patches occur at 5,000 feet elevation. The small stems are rarely over 10 or 15 feet in height, and in the majority of instances the lower part of the trunk is greatly twisted or coiled and nearly prostrate. The bitter cherry forms dense sprawling thickets in localities similar to those of the aspen, and is fairly frequent throughout the same range. The bent and semiprostrate stems are 6 to 12 feet high and 2 to 6 inches in diameter. The paper-leaf alder is also a thicket-forming species confined to the upper courses of small streams, boggy places, spring heads, and the moist, mucky borders of meadows. It occurs at 6,000 feet elevation, but is abundant only between 7,000 and 8,000 feet.

Shrubs.

Besides the small trees just mentioned, there are several shrubs which are conspicuous in forming a low thick chaparral cover on rocky and gravelly summits and slopes between 6,500 and 8,000 feet elevation. This cover is of considerable importance as a ground protection, and where abundant prevents the rapid descent of water on steep slopes. It is most abundant among the open and scattered growth of Jeffrey pine, lodgepole pine, and juniper, and with these trees constitutes the sole protection of the upper watersheds (see Pl. XCVI, *B*). Large areas of this low cover are frequently killed to the ground by fire, but the roots are almost never injured, so that, if the burning does not recur within two or three seasons, the cover is replaced by a crop of new shoots. It is evident in certain parts of these brush-covered areas, that the existence of the shrubs, the roots of which break up the softer rocks, finally make it easier for timber trees to become established than would otherwise be possible.

The most important of these shrubs is the "deer brush" (*Ceanothus*

A. A GOLD MINER AND HIS CABIN, SETTLED IN 1849.



B. COMMON METHOD OF HAULING YELLOW-PINE LOGS TO SAWMILL.

prostratus Benth.), and a green-leafed manzanita (*Arctostaphylos*), common at the lower levels, and Palmer oak (*Quercus vacciniifolia* Kell.) and chinquapin (*Castanopsis chrysophylla minor* de C.), abundant at the higher elevations.

RECAPITULATION.

Table showing the altitudinal range of principal trees in the lower, middle, and upper timber belts.

Species.	General range.	Area of greatest abundance.
LOWER BELT.	*Feet.*	*Feet.*
Gray pine	500 to 3,000	1,000 to 2,000
California rock oak	300 to 1,500	500 to 1,000
MIDDLE BELT.		
Yellow pine	2,000 to 6,000	3,000 to 5,000
Incense cedar	2,000 to 7,000	3,500 to 5,000
Sugar pine	2,000 to 7,000	3,000 to 5,000
White fir	3,800 to 7,500	4,000 to 5,000
Jeffrey pine	5,000 to 8,500	6,500 to 8,500
Red fir	2,000 to 5,500	3,500 to 5,000
Big tree	4,600 to 5,000	....
Calfornia black oak	1,500 to 6,500	3,500 to 4,500
Canyon live oak	1,500 to 6,000	3,000 to 5,000
Oregon maple	2,000 to 4,500	....
Pacific dogwood	3,000 to 5,000	....
Black cottonwood	3,000 to 6,500	....
White alder	2,000 to 5,000	....
Madroña	2,500 to 4,000	....
Tan-bark oak	3,000 to 5,000	4,000 to 4,500
Short-flower mahogany	3,000	....
Coffee berry	1,500 to 6,000	2,500 to 4,000
Western chokecherry	2,500 to 4,000	....
Pacific plum	3,000 to 4,000	....
Pacific yew	2,500 to 4,000	....
California torreya	2,000 to 3,000	....
UPPER BELT.		
Lodgepole pine	6,000 to 9,300	6,000 to 8,500
California red fir	6,000 to 8,500	6,500 to 7,500
Western white pine	6,500 to 9,400	7,000 to 8,500
Black hemlock	6,900 to 9,400	7,000 to 8,500
Western juniper	7,000 to 8,500	....
White-bark pine	8,000 to 9,500	....
Aspen	6,000 to 8,500	....

USES AND MARKET PRICES OF TIMBER.

The timber trees of greatest commercial value in this region are the yellow pine, Jeffery pine, sugar pine, white fir, red fir, and incense cedar. These supply nearly all of the sawed timber and all of the round and rived material used. The less important useful trees are the gray pine, live oak, California black oak, lodgepole pine, and California red fir. Together with several of the above more valuable species, these timber trees supply the fuel, fencing material, and round logs used for buildings.

LUMBER.

The major part of all sawed lumber is cut from yellow pine (including the small amount of available Jeffrey pine). This is supplemented to a considerable extent by sugar pine, white fir, and red fir. A large proportion of the lumber sawed consists of inch boards and planking, and to a less extent of large-dimension square timber. High percentages of the best grades of clear stock are produced by all these trees. The sugar and yellow pines furnish the greatest quantities of clear lumber and are used most widely for construction. The excellent quality of yellow pine fits it for the finest interior finish, while its strength and durability make it applicable for general construction.

All of the sawed lumber derived from the forests of this territory is consumed here, principally by settlers in the mining and agricultural districts, a very small amount being used in the higher wooded regions. This local consumption prevails because without railroad facilities the lumber can not be placed on markets outside this region at prices low enough to compete with larger lumber manufacturers operating in territory served by railroads. The chief uses made of sawed lumber is for general house building in settlements, and also for construction at gold-mining plants, where, with other lumber, considerable large square timber is consumed. Very little round timber is used at the present time for houses and other buildings, except for summer cabins in the high mountains.

All lumber is hauled by wagon from mills to the various local markets. The length of the haul is from 10 to 25 miles, and the average cost of such transportation is about $5 per 1,000 feet. The price for second-class yellow pine, sugar pine, white fir and red fir lumber at the mills is from $9 to $10 per 1,000 feet, while the price for first-class or clear lumber hauled to the towns and mining camps is from $16 to $23, and dressed clear lumber is worth from $25 to $30 per 1,000 feet.

Sawed incense-cedar telephone and telegraph poles are used to a limited extent, and are the most durable poles available in the region. Apparently the diseased condition common in incense-cedar timber (see Pl. CXIII, A) does not unfit the wood for such purposes, as badly affected samples were constantly seen doing good service.

A. WASTE IN LUMBERING

B. LOWER LIMIT OF YELLOW-PINE BELT.

STUDDING AND LAGGING TIMBER.

In addition to sawed timber used in mining operations, large quantities of round studding and rived lagging are consumed in deep shaft mining. These materials are derived almost entirely from yellow pine. Studding, which is used for large props, is cut from comparatively young pine—50 to 125 years old. The size of studding is 10 to 20 inches in diameter and from 16 to 18 feet in length (see Pl. CXIII, *B*). These logs are cut, peeled, skidded, and in order to lighten them are left to dry out for a time before hauling. The first cost of studding is about 50 cents per stick; hauled to the mines (distant 8 to 20 miles) it brings from $1 to $2 per stick. The large quantities of this timber used and the difficulty of hauling such heavy material in any but small amounts appears to keep up a lively demand.

Lagging timber, a small split or rived prop used extensively in surfacing mine shafts, is an important commodity. It is derived principally from mature yellow pine and occasionally from red fir. The pieces are 4 feet long, 4 to 6 inches wide, and about 2 inches thick. The average price paid for lagging delivered at the mines is about $16 per 1,000 pieces, and the distance hauled is from 10 to 18 miles.

SHAKE TIMBER.

"Shakes" are a form of shingle used exclusively in this region from an early day for roofing, and to some extent also for weatherboarding (see Pl. CIV, *B*). Except in some of the larger settlements near railroad communications, where sawed shingles can be had, shakes are still in common use. The best shakes are made from sugar pine, which is the timber used most commonly. They are also made from extra clear and straight-grained yellow and Jeffrey pine, and also from white and California red fir; but all are inferior to the sugar pine in wearing qualities. The sugar pine is preferred also because the timber can be rived more easily and because of the greater length of clear trunk available. For the most part, it is only when sugar pine is not available that other timber is used. Shakes are usually 36 inches long, 5 to 6 inches wide, and from one-fourth to one-half inch thick. Sugar pine of perfect quality for making shakes splits so smoothly that the shakes do not require shaving. The market price of shakes is from $5 to $7 per 1,000.

The widespread and long-continued use of sugar pine for shakes has resulted in the destruction and waste of much prime timber. Only a very small part, 15 to 20 per cent of each trunk, can be used, for the reason that the straight-grained portion of the trunk is of limited length; and as soon as the grain of shake bolts shows any twisting, the remainder of the tree is abandoned. A common sight throughout the middle timber belt are the huge partly used trunks of sugar pines felled for shakes. All degrees of waste are seen. After felling and a few trials at riving, some trees are found to be unfit and can not be used at all, while only 20 to 40 feet of other trunks have been used. This waste of good log timber left to rot seems wanton to the last degree, but in former years had some justification in the fact that necessity alone compelled settlers to use good shakes. Moreover, at that time, when the largest quantities of sugar pine were cut for shakes, there were few or no sawmills for utilizing the waste timber. There is, however, little excuse at the present time for the continuance of this waste, which is still to be seen in the middle timber belt (see Pl. CXI, A.)

FENCING TIMBER.

In the immediate vicinity of the larger settlements fencing is done with sawed pine and fir lumber and oak or incense cedar posts. The majority of ranches in the agricultural districts are fenced with barbed wire and rock oak and cedar posts; while in the timbered mountain districts sawed fencing is used only at occasional road stations. Barbed wire and split incense cedar posts and rails are most common in this region. Lodgepole-pine logs are also used in the range of this species for sheep and cattle corrals and other fencing. In some parts of the yellow-pine and upper timber belt thousands of acres of timber land are fenced for holding cattle by felling the largest trees in a line so as to form a continuous barrier. If skillfully felled, the huge trunks of incense cedar, sugar pine, yellow and Jeffrey pine, white and red fir, form effective and durable fences. However, the millions of feet of prime saw timber destroyed by this method of fencing is strikingly disproportionate to the amount of timber legitimately required to fence the land in the ordinary way.

Incense-cedar rails and posts are the lightest and most durable of all fencing timbers in this territory, and wherever available are generally used in preference to any other kind. There is a good demand for post timber of this kind throughout the settled districts, but posts are rarely hauled farther than 18 or 20 miles to supply this demand. The extensive use of incense cedar posts and rails in the past has resulted in the disappearance of almost all large trees within the above distance from settlements. The species is, however, very persistently reproduced in these sections, and if allowed to grow will furnish a continuous supply.

FUEL.

The fuel of this territory is very largely wood. Coal is used only in the southern and western border settlements near railroad communications. The trees furnishing fuel are chiefly gray pine, yellow pine, California black oak, rock oak ("white oak"), highland oak ("live oak"), and California white oak. Red alder is used occasionally, as is also red fir and incense cedar. California red fir and lodgepole pine are used to some extent by settlers in the upper timber belt. Gray

A. SOUTH FORK OF COSUMNES RIVER, NEAR COYOTEVILLE.

B. DENSE SECOND GROWTH OF YELLOW PINE

pine, yellow pine, rock oak, and highland or "live oak" are extensively used for domestic wood, and the latter is most highly prized. Fourteen-inch "live oak" readily commands the enormous price of $4 and $5 per cord at settlements. Four-foot wood of other oaks brings $6 to $7. Gold-mining plants consume the greatest quantities of cordwood, which is derived entirely from gray and yellow pine (see Pl. CXIV, A). The wood of these species contains a great deal of turpentine, and is therefore considered the best fuel for making steam. Yellow-pine fuel is superior to the gray pine. Large mines consume from 2,000 to 3,500 cords of 4-foot pine wood annually. The prices paid for this wood delivered at the mines varies from $3 to $6 per cord. The distance hauled is 7 to 18 miles.

With the present demand for pine fuel, yellow-pine woodland on the lower border of the middle timber belt can be profitably managed for cordwood. To be fully productive such woodland needs only protection against fire, and cutting so regulated that four to six seed trees per acre are left to insure rapid reproduction. Young yellow-pine forests 25 to 50 years old are now cut clean in the region of mining districts, and no seed trees are purposely left. As already shown, however, seed trees or groups are sometimes left by accident, and the cut-over areas are re-covered by the same pine. The gray pine, although far less productive than the yellow pine, could be made to give similarly good returns on otherwise barren foothills.

STANDING COMMERCIAL TIMBER.

The standing commercial timber of this territory is pine and fir, and is confined chiefly to the middle timber belt. The lower belt yields no saw timber. Considerable fir lumber could be obtained from the lower levels of the upper belt, but the rough, inaccessible nature of this region is likely to make lumbering in such high altitudes unprofitable for some time to come. These forests are not likely to be lumbered until the more valuable timber of the middle belt is severely depleted, and it is believed this can not occur within twenty-five years or more.

As already stated in describing the distribution of various timber species, the original area of commercial timber has been considerably reduced by complete clearing. Only a small percentage of such clearing has been done for securing agricultural land. The major part of forest land has been cleared by lumbering operations, since which it has been abandoned and more or less recovered by the same lumber species. A still smaller percentage of originally well-stocked forest land has been culled. Cuttings of this kind have been confined largely to the immediate vicinity of roadways, where mostly sugar pine has been taken out for shakes. The accompanying maps show the cut-over forest land which must be regarded now only as woodland. The markedly persistent reproduction of yellow pine and other timber species on these lands indicates, however, that they could be profitably maintained in forest if protected from fire and conservatively managed.

The timber forests of commercial value contain yellow pine, Jeffrey pine, sugar pine, white fir, red fir, and incense cedar. An examination of the following table will show the percentage of each species found in these forests. For completeness the percentage of stand has been given for a few other species also. The percentages of stand given are based on an extensive study of sample areas selected from representative parts of the various timber belts.

Table showing the percentage of stand for the principal timber trees, in localities where they are found.

Species.	Per cent of total stand.
Yellow pine	45 to 50.
Jeffrey pine	5; 30 to 40 on small areas.
Sugar pine	5 to 20.
White fir	30 to 45.
Red fir	2 to 5; 40 on small areas.
Incense cedar	20 to 30.
Big tree	1 to 3 on limited areas.
California red fir	40 to 100.
Lodgepole pine	50 to 100.
Silver pine	5 to 15.
Black hemlock	10 to 25.

As a basis for computing the yield of timber per acre, the trees on a large number of sample acres were measured. A few of these sample areas are presented in the accompanying tables, a study of which will give an accurate idea of the actual composition and character of the forests. Table 1 shows the number and size of each kind of tree, obtained by actual count and measurement, on sample areas so selected as to fairly represent the stand of timber in all parts of the territory. Table 2 gives the same species grouped so as show a comparison of dimensions and number of trees of the same species found on the different sample areas. Table 3 gives the average size and average number of different kinds of trees for all sample areas. The figures derived from these and other measurements are regarded as sufficiently representative of the entire timbered area to form a basis for the acre yields given, and also for the estimated total stand of commercial timber.

The acre yield of merchantable timber in these regions varies from 2,000 to 50,000 feet B. M., giving an average acre yield of about 20,000 feet for the middle belt, and 3,000 feet for the upper belt.

arter acre).

Sp	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	Average diameter (inches).	Average height (feet).	Number of trees.
Jeffrey pine																					46.8	150	6
White fir												1									46.2	182	15
White fir																					47.3	175	3
Yellow pine																					42.0	161	2
Incense ceda																					36.4	90	11
Sugar pine																					49.8	190	2
Yellow pine																					40.0	172	19
Incense ceda																				1	62.5	89	4
Sugar pine						1															44.8	185	16
White fir																					37.0	168	5
Incense ceda																					49.0	97	2
California bl																					28.2	50	7
Yellow pine																1					39.5	176	8
Incense ceda																					34.8	100	12
California re																					38.1	130	11
White fir																					35.7	158	20
Lodgepole pi																					27.6	60	14
White fir																					43.9	160	8
Sugar pine			1	1	1																62.5	190	4
Incense ceda										1											51.2	98	4
California re			1																		34.6	145	47
White fir																					37.4	166	20
California re																					35.0	139	4
Incense ceda																					35.5	88	3
Jeffrey pine																					39.0	125	1
Sugar pine																					40.5	187	2
Jeffrey pine																					43.7	151	9
Western whi																					26.5	120	11
California re																					27.8	127	41
Black hemlo																					22.5	70	15
Jeffrey pine				1																	50.5	152	10
White fir																					39.6	145	8
Incense ceda																					44.0	97	5
Sugar pine										1			1								65.8	186	4
Jeffrey pine				1																	55.9	147	3
White fir																					45.2	169	4
White fir																					40.4	171	6
Red fir		1					1		1				1	1							53.3	160	13
Incense ceda																					15.7	75	2
Sugar pine																					28.1	110	2
California re																					21.8	122	16
Lodgepole pi																					18.8	65	28
Western whit																					23.3	115	4
Incense ceda																					42.8	73	3
Red fir																					44.1	146	2
White fir																					37.1	157	15
Sugar pine																					37.6	156	3
Yellow pine																					45.4	164	4
Yellow pine																					24.2	145	19
Sugar pine																					35.0	118	4
Incense ceda																					23.4	70	6
California bla																					23.0	50	1
Yellow pine																					35.0	113	4
Red fir																					39.2	154	7
Incense cedar																					49.5	76	2
California bla																					27.6	48	2
Yellow pine																					25.6	145	17
Incense cedar																					21.7	62	9
Sugar pine																					37.0	120	1
California bla																					18.0	39	1
Incense cedar																					44.3	87	5
Yellow pine																					45.5	158	13
Red fir																					40.6	152	12
Incense cedar																					34.2	90	5
Sugar pine																					60.0	200	1
White fir																					41.6	170	3

Table I.

Table showing a comparison of the number, diameter, and height of timber trees on 22 sample areas (quarter acre).

Species	Sample area No.	Number of trees of various diameters on each sample area (diameter in inches, breast high).																																																																							Average diameter (inches).	Average height (feet).	Number of trees.
		11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80			
[illegible]	1																				1						1											1			1			1		1																								46.8	150	6
[illegible]																	1		1		2		1					1		1	1						1								1	2			1		1													1									46.2	182	15
[illegible]																																					1	1											1																											47.3	175	3
[illegible]	2																										1														1																																42.0	161	2
[illegible]																					1		1				1	1		1	2	3		1																																								36.4	90	11
[illegible]																																							1										1																										49.8	190	2
[illegible]	3										1								1		2			2		1	1				1	1	1	1	2	1			1		3																														40.0	172	19
[illegible]																																									1															2																					1	62.5	89	4
[illegible]															1						1	1	1		1		1				1				1	1		1	1		1	1				1					1							1																	44.8	185	16
[illegible]	4										1									1									1					1					1																																			37.0	165	5
[illegible]																																													1		1																															49.0	97	2
[illegible]								1				1	1				2									1								1																																									28.2	50	7
[illegible]	5			1					1							1						2															1		1																															1					39.5	176	8
[illegible]								1						1	1		1	1							2								2	1	1																	1																								34.8	100	12
[illegible]														1		1					1									1	1		1		1	3					1																																			38.1	130	11
[illegible]	6																	1				3	1	1	1	2		2	2	1	1	2	1									1																														35.7	158	20
[illegible]	7		1		1		1				1			1	2			1							2		1	1			1																																										27.6	60	11
[illegible]																							1						1		2							1						1	1			1																												43.9	160	8
[illegible]	8																																																											1				1	1	1																62.5	190	4
[illegible]																						1					1																											1										1												51.2	98	4
[illegible]	9				2		1	2	1		1		4	1	1	1	1	2	1		2	1	1	2	1	1		2	1	1	1	2	2		1		2	1	2		1			1										1																		31.6	145	47
[illegible]														1				1		1	1		2								2		2		1			2	3		1																																		37.4	166	20
[illegible]																				1				1							1				1																																												35.0	139	4
[illegible]	10																					1						1				1																																											35.5	88	3
[illegible]																															1																																																		39.0	125	1
Sugar pine	11																	1																													1																																40.5	187	2
Jeffrey pine																												1				1	1	1	1	1					1		1		1																														43.7	151	9
Western [illegible]								1	1		1				1	1						1		2		1		1	1																																													26.5	120	11
California [illegible]	12					1	1	2		3	2	3		1	2	2			4		1	3	5	1	1	2	2	1	1	2	1																																										27.8	127	41
Black [illegible]				1	1			2	1		1		1		3			1	2		1				1																																																		22.5	70	15
Jeffrey pine	13																							1														1		1		2		1		1		1						1				1																					50.5	152	10
White fir																						1										2			1	1	1			1	1																																				39.6	145	8
Incense cedar																						1										1								1	1							1																											44.0	97	5
Sugar pine	14																																																										1	1											1			1								65.8	186	4
Jeffrey pine																																										1									1							1																				55.9	147	3
White fir																																1						1	1								1																															45.2	169	4
White fir																1				1		1				1																													1				1																						40.4	171	6
Red fir	15																	1		1	1				1										1						1	1				1							1					1		1				1	1								63.3	160	13
Incense cedar				1					1																																																																									15.7	75	2
Sugar pine																	1				1																																																										28.1	110	2
California red fir			1		1		1		2	3	2				1	1	1		2				1																																																			21.8	122	16
Lodgepole pine	16	1	4	1		1	1	4	3	2	2	1	2	2	3			1						1																																																		18.8	65	29
Western white pine									1				1		1																																																																			23.3	115	4
Incense cedar																																			1							1				1																																			42.8	73	3
Red fir																																										1				1																																		41.1	146	2
White fir	17																						1	1			2			2	2	1			2						1					1																																	37.1	157	15
Sugar pine																										1				1												1																																						37.6	156	3
Yellow pine																															1							1											1		1																												45.4	164	4
Yellow pine					1	2		2	1		2	1	1				1	1	1				1	2	1			1	1																																															24.2	145	19
Sugar pine	18														1													1																																																					35.0	118	4
Incense cedar									1		1				1		1	1																																																																	23.4	70	6
[illegible]																1																																																																			23.0	50	1
[illegible]																				1				1								1						1																																								35.0	113	4
[illegible]	19																					1		1						1			2								1					1																																				39.2	154	7
[illegible]																																	2																																															19.5	76	2
[illegible]												1																			1																																															27.6	48	3
[illegible]				1				2			1				1	2	1		1	1	2	2	1				1					1																																													25.6	145	17
[illegible]	20		1		2				2						1					1	1	1																																																									21.7	62	9
[illegible]																																	1																																													37.0	120	1
[illegible]										1																																																																							18.0	79	1
[illegible]	21																1																				1			1				1		1																																				44.3	87	5
[illegible]																															1	1						3		1		2				1			1	3																													45.5	158	13
[illegible]																											2	2	1					1			1				1		1		1										1	1																									40.6	152	12
[illegible]	22									1									1				1											1											1																														31.2	90	5
[illegible]																																																										1																					60.0	200	1
[illegible]																				1																									1				1																														41.6	170	3

sample areas.

Sp	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	Average diameter (inches).	Average height (feet).	Number of trees.
Sugar pine..																					49.8	190	2
						1															44.8	185	16
			1	1	1																62.5	190	4
																					40.5	187	2
										1			1								65.8	186	4
																					28.1	110	2
																					37.6	156	3
																					35.0	118	4
																					37.0	120	1
																					60.0	200	1
Yellow pine																					42.0	161	2
																					40.0	172	19
																1					39.5	176	8
																					45.4	164	4
																					24.2	145	19
																					35.0	143	4
																					25.6	145	17
																					45.5	158	13
Jeffrey pine.																					46.8	150	6
																					39.0	125	1
																					43.7	151	9
				1																	50.5	152	10
				1																	55.9	147	3
Lodgepole pi																					27.6	60	14
																					18.8	65	28
Western whi																					26.5	120	11
																					23.3	115	4
Red fir......		1					1		1				1	1							53.3	160	13
																					44.1	146	2
																					39.2	154	7
																					40.6	152	12
White fir												1									46.2	182	15
																					47.3	175	3
																					37.0	168	5
																					35.7	158	20
																					43.9	160	8
																					37.4	166	20
																					39.6	145	8
																					45.2	169	4
																					40.4	171	6
																					37.1	157	15
																					41.6	170	3
California rec																					38.1	130	11
			1																		34.6	145	47
																					35.0	139	4
																					27.8	127	41
																					21.8	122	16
Black hemloc																					22.5	70	15
Incense ceda																					35.4	90	11
																				1	62.5	89	4
																					49.0	97	2
																					34.8	100	12
										1											51.2	98	4
																					35.5	88	3
																					44.0	97	5
																					15.7	75	2
																					42.8	73	3
																					23.4	70	6
																					49.5	76	2
																					21.7	62	9
																					44.3	87	5
																					34.2	90	5
California bla																					28.2	50	7
																					23.0	50	1
																					27.6	48	2
																					18.0	39	1

Table II.

Table showing a comparison of the number and dimensions of timber trees of the same species found on different sample areas.

Species	Sample area No.	Number of trees of various diameters of each species (diameters in inches, breast high): 11 to 80	Average diameter (inches).	Average height (feet).	Number of trees.
	2	[illegible]	49.8	190	2
	4	[illegible]	44.8	185	16
	8	[illegible]	62.5	190	4
	10	[illegible]	40.5	187	2
	14	[illegible]	65.8	186	4
	15	[illegible]	28.1	110	2
	17	[illegible]	37.6	176	3
	18	[illegible]	35.0	118	4
	20	[illegible]	37.0	120	1
	22	[illegible]	60.0	200	1
	[illegible]	[illegible]	42.0	161	2
	[illegible]	[illegible]	40.0	172	19
	[illegible]	[illegible]	39.5	176	8
	[illegible]	[illegible]	45.4	164	4
	17	[illegible]	24.2	145	19
	18	[illegible]	35.0	[illegible]	4
	19	[illegible]	25.6	[illegible]	17
	20	[illegible]	45.5	[illegible]	[illegible]
	21	[illegible]	46.8	150	6
	1	[illegible]	39.0	125	1
	10	[illegible]	43.7	151	9
	11	[illegible]	50.5	152	10
	[illegible]	[illegible]	55.9	147	3
	14	[illegible]	27.6	60	14
	7	[illegible]	18.8	65	[illegible]
Western [illegible]	16	[illegible]	26.5	120	[illegible]
	12	[illegible]	23.3	115	4
Red fir	16	[illegible]	53.3	160	[illegible]
	15	[illegible]	44.1	146	[illegible]
	17	[illegible]	39.2	154	[illegible]
	19	[illegible]	40.6	152	12
	22	[illegible]	46.2	182	15
White fir	1	[illegible]	47.3	175	[illegible]
	2	[illegible]	37.0	[illegible]	5
	4	[illegible]	35.7	178	20
	6	[illegible]	43.9	[illegible]	[illegible]
	8	[illegible]	37.4	166	[illegible]
	10	[illegible]	39.6	[illegible]	[illegible]
	11	[illegible]	45.2	[illegible]	[illegible]
	14	[illegible]	40.4	171	6
	15	[illegible]	37.1	157	15
	17	[illegible]	41.6	170	8
	22	[illegible]	38.1	150	11
California [illegible]	6	[illegible]	34.6	145	47
	9	[illegible]	35.0	[illegible]	4
	10	[illegible]	27.8	127	42
	12	[illegible]	21.8	[illegible]	16
	16	[illegible]	22.5	70	15
Bla[illegible]	12	[illegible]	36.4	90	11
Incense [illegible]	2	[illegible]	62.5	[illegible]	4
	[illegible]	[illegible]	49.0	97	[illegible]
	4	[illegible]	34.8	100	12
	[illegible]	[illegible]	51.2	[illegible]	[illegible]
	8	[illegible]	35.5	[illegible]	[illegible]
	10	[illegible]	44.0	[illegible]	[illegible]
	14	[illegible]	15.7	[illegible]	[illegible]
	15	[illegible]	42.8	[illegible]	[illegible]
	17	[illegible]	23.4	[illegible]	6
	[illegible]	[illegible]	49.5	[illegible]	[illegible]
	19	[illegible]	21.7	[illegible]	[illegible]
	20	[illegible]	44.3	[illegible]	[illegible]
	21	[illegible]	34.2	[illegible]	[illegible]
	22	[illegible]	28.2	[illegible]	[illegible]
	5	[illegible]	25.0	50	1
	18	[illegible]	27.6	48	[illegible]
	19	[illegible]	18.0	39	[illegible]
	20	[illegible]	[illegible]	[illegible]	[illegible]

ᵉc).

S	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	Total number of trees.	Total number of sample areas.	Average diameter for total number of trees (inches).	Average height for total number of trees (feet).	Average age (years).
Sugar pine..	1	1	1	....	....	....	1	....	....	1	....	....	....	....	....	....	....	39	10	47.7	164.2	375
Yellow pine	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	86	8	37.9	158.0	380
Jeffrey pine	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	29	5	47.5	145.0	260
Lodgepole p	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	12	2	23.6	62.5	135
Western wh	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	15	2	24.9	117.5	210
Red fir......	....	....	....	1	....	1	....	....	....	1	1	....	....	....	....	....	....	34	4	44.6	153.0	350
White pine .	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	107	11	41.2	166.0	290
California re	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	119	5	32.0	132.6	275
Black heml	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	15	1	22.5	70.0	185
Incense ced	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	1	73	14	40.9	86.0	150
California bl	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	11	1	21.5	47.0	190

Table III.

Table showing average diameter measurements of various timber species for sample areas (quarter acre).

Number of trees of various diameters on sample areas, diameter in inches, breast high.

Species.	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Sugar pine			....	....	....	....	....	....	....	....	....	1	1	....	2	....	....	....	2	1	1	....	1	2
Yellow pine			....	2	5	1	2	1	3	....	....	....	5	5	8	....	2	1	8	2	2	4	2	4
Jeffrey pine			....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	....	....	....	1
Lodgepole pine			1	1	2	4	3	2	3	1	2	3	5	....	....	2	....	....	....	....	1	2	....	1
Western white pine				1	2	....	1	....	1	1	2	....	....	....	....	....	1	....	2	....	2	....	1	1
Red fir				....	....	....	....	....	....	....	....	....	....	....	1	....	2	3	3	1		1	....	....
White pine		....	....	....	....	1	....	....	1	1	....	2	1	1	2	2	2	2	10	2	6	2	4	
California red fir		....	4	1	4	2	6	5	6	....	6	3	5	2	2	2	2	2	5	7	6	3	6	
Black hemlock	2	1	....	....	2	1	....	1	....	1	....	3	....	....	1	2	....	1	....	....	....	1	....	....
Incense cedar	1	1	2	....	1	1	5	....	....	....	2	2	1	1	1	....	2	3	4	....	3	....	2	
California black oak	....	....	....	....	....	1	1	1	....	1	1	1	....	....	2	....	....	....	....	....	....	....	1	1

Species.	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
Sugar pine	1	1	....	....	1	....	....	....	2	2	....	1	1	....	1	2	....	....	....	2	....	....	1	1
Yellow pine	5	1	....	....	1	6	1	3	3	1	....	....	2	1	3	1	1	1	....	....	....	....	....	....
Jeffrey pine	1	....	....	2	1	1	1	1	1	....	2	....	1	....	2	1	2	....	2	....	2	....	....	....
Lodgepole pine	1	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Western white pine	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Red fir	2	....	....	3	....	....	1	2	....	1	2	1	....	1	1	1	....	....	1	....	1	1	....	....
White pine	5	5	8	6	5	1	4	2	3	5	5	1	1	....	2	1	3	....	2	5	1	....	1	....
California red fir	1	1	5	2	2	2	1	3	1	....	2	1	3	....	1	....	....	1	....	....	....	....	....	....
Black hemlock	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Incense cedar	1	1	3	4	4	2	1	2	....	1	2	2	1	....	3	....	1	....	1	....	....	1	....	....
California black oak	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Species.	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	Total number of trees.	Total number of sample areas.	Average diameter for total number of trees (inches).	Average height for total number of trees (feet).	Average age (years).
Sugar pine	3	....	....	1	1	1	1	....	....	....	1	....	....	1	....	....	....	....	....	....	....	39	10	47.7	164.2	[illegible]
Yellow pine	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	86	8	[illegible]	[illegible]	[illegible]
Jeffrey pine	1	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	29	5	47.5	145	[illegible]
Lodgepole pine	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	12	2	[illegible]	[illegible]	[illegible]
Western white pine	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	15	2	21.9	117	[illegible]
Red fir	....	....	1	....	....	....	....	1	....	1	....	....	....	1	1	....	....	....	....	....	....	[illegible]	4	44.6	[illegible]	[illegible]
White pine	2	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	107	11	31.2	[illegible]	[illegible]
California red fir	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	119	5	[illegible]	[illegible]	[illegible]
Black hemlock	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	15	1	22.5	70.0	285
Incense cedar	3	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	1	73	11	[illegible]	[illegible]	[illegible]
California black oak	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	11	4	21.5	47.0	[illegible]

A. DEFECT IN ALL LARGE INCENSE-CEDAR TIMBER.

B. YELLOW-PINE "STUDDING" SKIDDED FOR HAULING TO GOLD MINES.

Following are the statistics of area and estimated stand of timber in each of the six quadrangles examined:

Land classification in Placerville quadrangle, California.

	Square miles.
Cultivable lands	178
Lands covered with chaparral	317
Grazing lands	2
Burned lands	5
Cut lands, restocking with timber	122
Culled lands	162
Virgin timber	152
Total	938

The total stand of timber upon this quadrangle is estimated at 1,600 million feet B. M. The average stand of timber per acre on the timbered land, including the culled land, is 8,000 feet B. M.

Land classification in Jackson quadrangle, California.

	Square miles.
Cultivable lands	373
Lands covered with chaparral	349
Burned lands	23
Cut lands, restocking with timber	175
Culled lands	18
Total	938

The total stand of timber remaining upon the culled lands is estimated at 40 million feet B. M. There is no virgin forest land upon this quadrangle.

Land classification in Pyramid Peak quadrangle, California.

	Square miles.
Barren lands (partly chaparral-covered foothills and partly high mountain summits)	110.5
Grazing lands	7.5
Culled lands	148.0
Lands covered with virgin timber	642.0
Total land area	908.0

The total stand of timber upon this quadrangle is estimated at 3,400 million feet B. M., an average of 6,700 feet per acre of timbered land.

Land classification in Big Trees quadrangle, California.

	Square miles.
Cultivable land	7
Barren lands, consisting in part of chaparral and in part of rocky summits	164
Grazing lands	4
Burned lands	2
Cut lands, restocking	89
Culled lands	104
Lands covered with virgin timber	564
Total	934

The total stand of timber upon the quadrangle is estimated at 3,750 million feet B. M. The average stand of timbered land per acre is 7,700 feet.

Land classification in Markleeville quadrangle, California.

	Square miles.
Lands covered with chaparral	318
Grazing lands	283
Lands covered with virgin timber	322
Total land area	923

The total stand of timber upon this quadrangle is estimated at 320 million feet B. M. The average stand per acre of timbered lands is 1,500 feet.

Land classification in Dardanelles quadrangle, California.

	Square miles.
Chaparral-covered lands	240
Grazing lands	39
Lands covered with virgin timber	659
Total	938

The total stand of timber upon the quadrangle is estimated at 3,000 million feet B. M., giving an average stand per acre of 7,100 feet.

The total stand of timber upon these six quadrangles is estimated at 12,110 million feet B. M.

Of the total area of Stanislaus Reserve—1,080 square miles—924 square miles were included in this examination. Of this area, the lands are classified as follows:

Land classification in Stanislaus Reserve, California.

	Square miles.
Barren, consisting mainly of high, rocky lands	251.0
Grazing lands	32.5
Timbered lands	640.5
Total	924.0

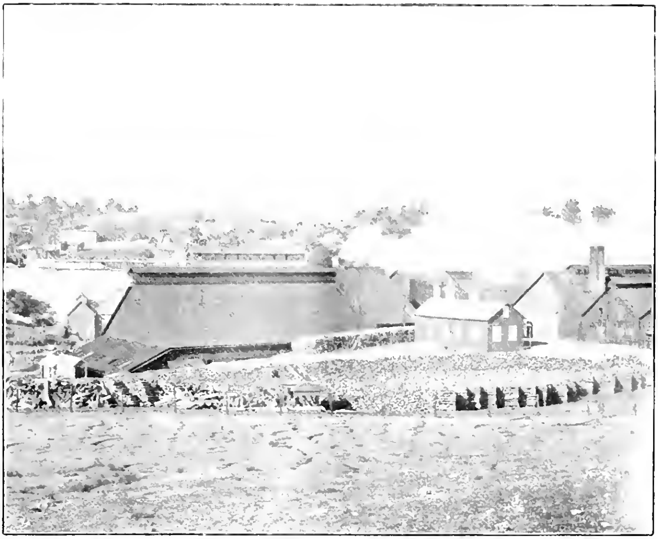
The total stand of timber upon this area is estimated at 2,000 million feet B. M., giving an average stand per acre of 5,000 feet.

Of the total area of Lake Tahoe Reserve—213 square miles—193.5 square miles were examined. The following is the classification of these lands:

Land classification in Lake Tahoe Reserve, California.

	Square miles.
Barren, consisting of high, rocky summits	58.0
Grazing lands	3.0
Culled	3.0
Timbered lands	129.5
Total	193.5

The total stand of timber upon this area is estimated at 322.5 million feet B. M. The average stand per acre is nearly 3,000 feet.



A. LARGE MINING PLANT AT ANGELS CAMP, SHOWING THE GREAT QUANTITY OF YELLOW-PINE CORD WOOD CONSUMED.

B. CANYON OF COYOTE CREEK LOOKING NORTH FROM A POINT 2 MILES SOUTH OF VALLECITO.

REDUCTION AND MODIFICATION OF FORESTS BY VARIOUS INDUSTRIES AND THEIR EFFECT ON REPRODUCTION.

LUMBERING AND OTHER TIMBER-CONSUMING INDUSTRIES.

The largest areas of forest land have been denuded and cut over for saw timber and mining timber. Altogether, shake making has also made large inroads on the prime sugar pine. As this pine occurs in mixture only, the more extensive cutting for shakes—sometimes taking the sugar pine clean—has resulted in only a thinning of the original forest. The enormous amount of timber wasted by shake-makers has already been referred to. Naturally, the constant demand, from an early date, for shake timber has carried this industry over a large part of the middle timber belt. The major part of this cutting has, however, been carried on along and near the principal wagon roads. Occasional transient settlements were formed in regions of the largest supply of sugar pine, and continued for a number of years, but with the failure of timber these settlements were moved to other points. Squaw Hollow was originally a shake makers' settlement of considerable size, but has long since disappeared, along with its once abundant supply of sugar pine. It was situated between the Calaveras and Stanislaus big-tree groves.

Unlike the cuttings for sawmills, those for shake making commonly left small trees, and occasional large trees unfit for riving on account of a too twisted grain. As a result, with few exceptions, the forests cut over by shake makers have not been deprived of seed trees, and there has been a continued reproduction of sugar pine (see Pl. XCVI, A).

But the cutting for lumber and mining timber has been quite different. Considerable areas have been stripped, as shown in the accompanying maps (Pls. LXXXV–XC, in atlas). As a consequence of clearing, the reproduction of all the species removed has been prevented or retarded to a great extent. With the subsequent ravages of fire, some cut-over lands have remained in a denuded state for many years, and are still in this condition. Moreover, the proportions of the original composition have been materially changed, because, even under the same circumstances, all the tree species concerned are not equally persistent in reproducing themselves. The sugar pine is the least so. The yellow pine, incense cedar, and white fir are persistent species, and are the first to come back to denuded lands; and the proportion in which they form the second growth varies according to the nearness and abundance of seed trees of each kind. Under all circumstances the yellow pine will return in the largest proportion, while the sugar pine, originally a considerable part of the forest, is likely to be the last to come back and may require many years to establish its former proportion of stand in the forest.

Conservative cutting for sawmills, in place of the prevailing method of stripping the land, would not disturb the advantageous proportions of mixture present in forests not yet lumbered. Provision could then be made for the reproduction of all useful timber trees.

The method of lumbering employed in this territory from the earliest time to the present is very wasteful of timber. A very common sight, in all districts where lumbering is going on, is the enormous waste of tops. The clear trunk is cut into logs, and the remainder of the stem left (see Pl. CXI, *A*). The size of the tops left is from 18 to 36 inches or more in diameter at the large end, with a total length of 25 to 40 feet. This timber is usually sound, but has limbs throughout its length, and is therefore considered undesirable. An estimate of this waste gives from 3,000 to 5,000 feet B. M. per acre. To one familiar with the extreme economy of timber now practiced in the depleted pine forests of the East, this waste is wanton. Without discussing the reasons for this practice, among which are urged that top lumber is too knotty to be saleable and that there is enough clear timber, the neglect of so much top timber makes forest fires very destructive. The lumberman himself is in position to feel this, for cases were seen where the big timber not yet lumbered out was destroyed or greatly damaged by uncontrollable fires in masses of tree tops (see Pl. CVI, *A*). A more complete destruction also of all young growth takes place in such localities than is possible from the ordinary light surface fires.

The cutting of cord wood and mining timber is attended with little or no waste. This is not from design, but chiefly because mining timber and wood are cut in thinly stocked parts of the pine belt, and it is most profitable to be economical. The entire trunks are worked up in cutting cord wood, leaving only the branches, while the tops left from studding timber are cut into cord wood (see Pl. CXII, *B*). Such methods are ideally thrifty. The branches left soon decay, and altogether there is much less débris left for fires than there is in the track of the lumberman.

GRAZING.

Grazing in this region is mostly by sheep, goats, and cattle, and to a much less extent by horses. Next to mining, grazing is the oldest industry of the region. Its importance is also very great, and in considering the possible evil effects the industry may have on the forests, this must be fully borne in mind. The bare condition of the surface throughout the forests is so easily referable to grazing and the latter is thus so apparently destructive to forest reproduction and the conservation of water that a very careful study must be made of all possible conditions bearing on the subject before a fair conclusion can be drawn. The effect of grazing on reproduction and water flow is a subject of great contention among those interested in grazing privileges on public forest lands and those believing such rights should be denied. The opinions given and the evidence adduced on both sides seem conclusive from the standpoints of the contestants. This may argue that enthusiasm on the one side and vital interests on the other have overlooked some facts which should be appreciated by both sides. Carefully considered, the propriety of grazing forest land in this territory can not be denied nor affirmed by the study of any one locality, a kind of investigation which is believed to have formed the basis of opinion for and against grazing privileges.

The investigation of the effects of grazing on forest growth and its protective functions involves a careful consideration of the relation of forest fires to grazing. Just how far the one or the other may be responsible for certain conditions avowedly unfavorable to forest growth is difficult to show, but that the combined effects of fire and grazing are or may be damaging to forest reproduction and the conservation of water can not be denied.

In traversing the timbered portions of this territory the observer is impressed with the following facts. First, in unfenced forests: The general lack of herbaceous growth and irregular reproduction of timber species; the general absence of small-sized timber intermediate between seedlings and the large timber. Second, in fenced and otherwise protected forests: The uniform abundance of herbaceous growth; a plentiful reproduction of timber species; the presence of intermediate sizes of small timber. These conditions prevail in proportion to the length of time during which complete protection has been given.

Pls. XCII, *A;* CI, *B;* CII; CV, *A*, and CVI, *B* illustrate clearly the above extreme conditions. The best opportunity offered for observing protected forest conditions was in the Calaveras big-tree grove, which has been protected from all kinds of grazing and almost entirely from fire for 30 to 40 years. Another case of several thousand acres protected for 15 to 20 years was found on and near the headwaters of the North Fork of Tuolumne River. Smaller areas protected for 5 to 15 years were studied at various points in the upper timber belt; while the effects of unchecked fire, promiscuous grazing, and the separate effects of sheep and cattle grazing were observed throughout the unprotected forests of the entire region. These latter conditions have prevailed more or less for 40 or 50 years. No check has been given to the annual fires, and practically no restraint has been put upon the number of animals grazed in the region.

As a rule, there is no promiscuous grazing of cattle and sheep on the same range during the same season, for the reason that cattle will not graze on a range over which sheep have previously gone. The two kinds of grazing are separated, each continuing more or less over its own range for one or several seasons. Sheep and cattle ranges on public and other unfenced forest lands are held mainly by the right of priority, or sometimes by the common agreement of sheepmen and cattlemen. Most of the cattlemen claim to own summer ranches, in the vicinity of which they endeavor to maintain a free range for their stock. At the present time very few sheepmen have summer ranches in the lumbered regions, but select such ranges as are not seized for cattle, and assiduously encroach upon adjoining cattle ranges whenever possible. There is evidence that years ago there were many permanent sheep ranches in various parts of this territory. None of these are maintained now. The sheepmen appear to be wanderers, while the cattlemen seem to hold the balance of power in point of preferred range land. This advantage is strengthened also by a right to graze in the forest reserves, from which the sheepmen are nominally excluded by law.

It is evident, however, that, although cattle grazing is now carried on over the best range, sheep grazing has, on the whole, obtained over a far more extensive territory and for a much longer time. As is well known, there is a striking difference between the effects of sheep and cattle grazing on vegetation. This is best seen in protected ranges used by cattle and those used exclusively by sheep. The latter feed so closely that if the range is overstocked for any length of time there will not be a vestige of forage left. Cattle feed much less closely, and even in overstocked ranges, unless the animals are confined by fences, the grazing is not so continuously close and is never wholly destructive to herbaceous plants. The animals wander much, and will even grow thin when a habit of closer feeding would give them sufficient food. There is one other important difference between the grazing of sheep and cattle. The latter usually feed singly, or not more than a few individuals together, while sheep almost always feed in close bands. As a result, the surface of the ground is more continuously trampled by sheep than by cattle, from which it follows that with closer feeding and closer trampling sheep may do greater damage to low vegetation than cattle. Just these differences can be observed in localities where the two kinds of grazing are separate. Moreover, it may be said that several bands of sheep seen in this territory were so driven by hunger and the lack of all other forage that they ate small conifer seedlings, browsed young firs and pines, and where these were not available they devoured even the fallen dead pine and fir leaves. Cattle never browse on conifers, even under the severest stress of hunger, but do feed on broad-leaf shrubs and young trees within their reach.

Excepting in high mountain meadows, all of which are fenced and which are grazed by cattle, the principal forage for sheep and cattle on the open forest range consists of a few very hardy shrubs and low broad-leaf trees. There are practically no grasses or other herbaceous plants. The forest floor is clean (see Pls. CI, *B;* CIII, *A*, and CIV, *A*). The writer can attest the inconvenience of this total lack of grass forage, for in traveling over nearly 3,000,000 acres not a single day's feed for saddle and pack animals was secured on the open range. This is in striking contrast to the rich forage range in the timber forests of the Rocky Mountains. Barrenness is, however, not an original sin. From a study of long-protected forest land in the same region, and from the statements of old settlers, it is evident that formerly there was an abundance of perennial forage grasses throughout the forests of this territory. A dense growth of these grasses and many other herbaceous plants are plentiful now in all long-protected forests, whether grazed or not by cattle and horses. It is also true that the severest annual surface fires kill these plants only to the ground; unless uprooted they sprout up the following season. It would seem that this bare condition of the surface in the open range has been produced only through years of excessive grazing by millions of sheep—a constant overstocking of the range.

The inference, however, that sheep grazing is largely, if not entirely, accountable for the lack of forage plants in these forests can not at present be made to include entirely the destruction of young seedling trees. Nor can it be concluded that a limited number of sheep may not be grazed without completely baring the surface.

The more important consideration in this matter is the kind of damage and the manner in which sheep grazing may affect the usefulness of timber and protective forests. Unquestionably many millions of tree seedlings have been trampled to death by sheep, but frequent forest fires have also gone over the same ground. With the evidence now at hand all that can be safely said is that together fires and excessive grazing have reduced the ground cover to almost nothing. What the one has left the other has most likely destroyed.

To determine exactly how much damage sheep grazing does to reproduction would require extended careful study of sheep-grazed forest land entirely free from fire; but, carefully considered, there is a close relationship between the origin of many forest fires and sheep grazing. How generally sheep herders are accountable elsewhere for fires can not be stated, but the writer's observations in the region under consideration show that a large number of fires are due to the presence of sheep herders. Some of these fires were due to carelessness and some were purposely set. Several fires destroyed thousands of conifer seedlings and also set fire to hundreds of acres of large standing pines previously burned in the trunk and thus continued this peculiar gradual destruction of timber which is going on so generally from year to year (see Pl. CI, *B*.)

These fires proceed from neglected camp fires, from purposely fired fallen timber, and also from the deliberate setting of fires in high chaparral. Fallen timber forms troublesome barriers to driving sheep along regular routes, and the herders set fire to these logs, usually as they are leaving a "fed-out" range, in order that the way may be open on their return. No less than seventeen fires of this kind were found on the trail of one band of sheep, covering a distance of 10 miles. The other kind of burning referable to sheep herders occurs in high manzanita and ceanothus chaparral. This brush finally grows so high that sheep can not feed from it, and in places is often so dense that they can not pass through it. These areas are burned over either to produce low sprouts or for the double purpose of feed and access. It frequently requires two seasons' burning to clear away manzanita brush—the first to kill the brush and the second to consume the dead, horny stems. Frequent fires of this kind destroy all young tree growth within the area burned, for, when once started, even the green manzanita burns very fiercely.

In conclusion, it may be again stated that surface denudation of forest land is general throughout the middle timber belt and in the lower part of the upper belt. It is believed that the excessive sheep grazing of the past and present, together with the fires known to be caused by sheep herders, have contributed very largely to the production of this bare condition. Proportionately this industry has also retarded forest reproduction and through incidental fires destroyed much young growth and damaged old timber. As a consequence, the general protective functions of the forests have been appreciably lessened, for the bare surface allows a rapid run-off of water and destroys an equable flow of water in streams.

The inference from these conditions is that there should be a prompt regulation of the excesses producing these conditions. The preservation of a most important industry—sheep grazing—and the fullest usefulness of the forests of this region demand such action. An inspection of the region will show that certain areas require immediate exemption from sheep grazing and absolute protection from fire in order to allow a full reproduction in all open ground. This is imperative if the fullest sustained yield of timber is to be secured in these forests, because almost all of the timber now standing is mature. A complete harvesting of this timber would result, as it has in old lumbering operations, in almost total denudation. With some exceptions, reproduction has been so generally suppressed that there is little young timber to replace the old stand within a reasonable time (see Pl. CI, *B*).

Following the establishment of a young forest growth, limited grazing can be practiced for a term of years without fear of retarding reproduction. Adequate regulation of such grazing should, however, not allow the close, successive feeding, of sheep especially, which will denude and extirpate all herbaceous growth, a cover so much needed as a help in preventing surface washing. The thrifty stock raiser of old countries does not graze his pastures into the earth. He limits the number of animals or the time for using a range. In the present region, however, regulation of this kind can not be left to sheep herders, who consider the feed for the season only. Unbiased, competent inspection of this forest range should determine the number of animals and the length of time they should graze in one locality, or whether certain parts of the range should be grazed at all. With this is also needed a perfect enforcement of provisions against violations. Incidentally it may be remarked that the writer's observations of this season show that in a number of cases unless a ranger's warning to sheep herders to leave the forest reserves is accompanied by the power of immediate eviction the request was treated with contempt, or with a reply that "bullets alone will be obeyed."

FOREST FIRES.

EFFECT ON REPRODUCTION AND STANDING TIMBER.

Forest fires have prevailed in this territory since a very early period, and they are still frequent and widespread. There is evidence that a much older forest than is represented in the present growth once existed here and that much of this growth has been gradually destroyed by fire. A very few of these trees—yellow pine, sugar pine, and white fir—are occasionally met with now. They are nearly twice as old as the oldest recent growth and could not well have disappeared through any other agency than fire. What the character of the older fires was is impossible to state. Most likely, however, they were similar to those common in this region to-day. The fires of the present time are peculiarly of a surface nature, and with rare exception there is no reason to believe that any other type of fire has occurred here. Parts of the older forests may have had a deep humus, which, being burned, would have destroyed timber by deep burning at the roots. But there being no humus at the present time, deep burning is impossible. The tree roots are for the most part buried deep in the crevices of bare rock, in gravel, sand, or shale, over which surface fires run annually without the slightest direct injury to the roots. Barring the débris left from timber-cutting, the only food for these fires is the scanty fall of pine and fir needles, irregular patches of low conifer seedlings, and chaparral. In general, these materials limit the fires to surface burning. The destruction wrought is, however, serious. Millions of tree seedlings are destroyed annually in one or another part of the region (see Pl. C, *A*). The exemption of certain localities from fire is a mere accident, and except where special protection is maintained a locality is not likely to be spared longer than a dozen years. This young growth is killed outright save such trees as have grown high enough to escape a complete singeing. Dense stands of yellow pine 25 to 50 years old suffer a thinning every time surface fires run through them, and not infrequently the younger stands succumb entirely. The amount of damage done to young pine forests by surface fires depends largely on whether the burning is accompanied by high winds. With little or no wind the fire may consume the scant litter in a desultory sort of advance, but if fanned by a stiff breeze the flames usually reach the branches and scorch the close-standing crowns. This usually kills even the 40 or 50 year old trees.

The instances in this region where large timber has been killed outright by surface fires are comparatively rare. Two cases only were found, and are shown on the accompanying map (see Pl. LXXXVIII, in atlas). One of these burns involved less than an acre, and the other included several hundred acres. They are exceptional cases, and the killing of the trees is accounted for by the fact that long protection from fire and from all but cattle grazing had resulted in the accumulation of much fallen timber, considerable humus in depressions and on benches, and a dense undergrowth of brush and seedlings. The fires burned deep enough to badly injure the surface roots, which resulted in the subsequent death of the timber.

The most serious and widespread injury to mature timber caused by surface fires is in the gradual hollowing out from year to year of the green trunks near the base. The extent of this damage is very great. In the middle or main timber belt it is scarcely possible to find a tree trunk not blackened by fire, and from 50 to 75 per cent of the trees have fire scars burrowed out in the green wood (see Pls. XCII, *B*; XCIV, *A*; XCIX, *A*, and CII, *A*). These scars are from a few inches to 15 or 20 feet long and from 6 inches to 2 feet wide. Frequently also the trunks are scorched for 30 to 60 feet above the scar. Burning in the scar continues more or less from year to year, and results in felling the tree (see Pl. CIX, *B*). The cause of this peculiar damage is due primarily to the presence of resin on the bark, while the persistence of the burning is due to the resin on the surface of the fire scar. In the first place, the bark of many trees is punctured by woodpeckers in search of borers, which are especially plentiful in yellow pine. A great many sugar pines also have been chipped by shake makers to test the straightness of the grain. Quantities of resin exude from these wounds and smear the trunks down to the ground. Surface fires ignite the inflammable resin, and it burns fiercely, deepening the chip marks and burrowing into the green wood wherever woodpeckers have exposed even the smallest surface. The green wood is so thoroughly charged with resin at the points of injury that the fire persists for a long time, heating the wood to a depth of several inches. After the fire has ceased a congestion of resin follows at this point, and during the next season or two more resin is exuded and smears the scar and adjoining parts. The next fire burrows in deeper. Others follow from time to time, each burning with greater vehemence, until at last the trunk becomes a thin shell and the tree falls. The rapidity and persistence with which these fires burn in the green wood of trunks is almost inconceivable. After the fire has burned well into the trunk the heat produced is very intense, drying out the moisture and drawing out the abundant resin to feed the flames. The pines are damaged more severely at each burning than are the much less resinous firs and incense cedar. Being most persistent in resinous woods, this type of fire is confined chiefly to the middle pine belt region.

The amount of destruction wrought by trunk fires is difficult to estimate, but involves approximately from 1 to 5 per cent of the total stand. It is difficult, also, to determine how many attacks the trees endure before succumbing. The amount burned each time is exceedingly irregular, as are also the periods at which the timber takes fire. Strangely enough, trees with half burned off trunks, and some even more severely damaged, show no signs of declining vigor. Such trees fruit freely and appear vigorous to the last.

ORIGIN OF FOREST FIRES.

The habitual dryness of this region during the summer renders it most susceptible to fire, and therefore the greatest care needs to be taken to prevent very frequent occurrence of fires.

The origin of a large number of forest fires has already been referred to under the heading Reduction and modification of forests by various industries and their effect on reproduction. The causes there described were determined by actual observations, and are believed to account for the majority of fires occurring in the timber belts of this region. This conclusion is strengthened by the fact that the people carrying on grazing, milling, etc., have occasion to use fire in forested regions more than any other class of settlers or sojourners. Sheep herders are campers, and, in addition to carelessness with camp fires, find it to their interest to deliberately set fires under certain conditions. Cattlemen are summer settlers in the forests and have some interest in the suppression of fires through the fact that they maintain fences and rude buildings which would be endangered by carelessness with fire. Moreover, the burning of brush and fallen timber are rarely of the same advantage to these men as to the sheepmen. Cattle are not herded as are sheep in feeding, but allowed to roam at large; and they feed from the tallest brush without difficulty, and otherwise give the ranger little trouble except to see that they do not wander off the range.

Milling operations are productive of fires through carelessness. Jams of tops are frequently set on fire by loggers to open blockaded roads or ways. These fires usually escape and do damage elsewhere. The use of imperfect spark arresters on donkey logging engines is also a source of many fires. A serious fire from this cause was witnessed in timber near the headwaters of Love Creek, where a considerable quantity of standing and cut saw timber was destroyed through the burning of immense quantities of waste tops. Fires occasionally originate from the small clearing operations of settlers in timbered districts. Two fires of this kind escaped from smouldering log heaps and spread through a wide strip of timber.

There are probably comparatively few fires caused by campers and hunters. This is due to the fact that of necessity such camping is confined largely to the vicinity of road stations and ranches where only, for the most part, it is possible to get horse feed. To a great extent this prevents the promiscuous use of fire by these people at points unguarded by settlers. Moreover, as compared with other regions plentifully supplied with game and fish, the depleted supplies of this region offer few inducements to hunters; and hence there are few such excursions.

PRECAUTIONS AGAINST FIRES.

Forest fires were very prevalent during the summer of 1899; so much so that travel through a large part of the territory was at times difficult on account of dense smoke. They began during the latter part of August and continued to increase till near the end of October, when they were put out by snow and rain.

While there is a wholesale fear of forest fires among settlers in the timbered districts, almost no precautions are taken to guard against the spread of fires, except when threateningly near at hand. Permanent settlers in the foothill country express much graver fears of fires from the adjoining timber which are likely to spread wildly through the dead grass and brush of the lower levels. Fires of this kind are not infrequent and often destroy fences, buildings, and hay crops. The entire lack in these sections of green herbaceous vegetation from July to October and the excessive dryness of the ground make the region most susceptible to fire. As a consequence some precautions are taken to prevent the spread of fires in these sections; in fact the safeguards seen here were the only ones found anywhere. They consist in clearing lanes 4 to 10 feet wide across dangerous parts of the country. This requires principally the scraping away of the dead grass from the hard, dry surface. Usually these firebreakers are effective, especially the wider ones. A still more effective break, but more rarely resorted to, is made 15 to 20 feet wide by carefully burning over a strip between two scraped lanes.

PUBLIC SENTIMENT TOWARD FOREST RESERVES.

Nearly all settlers interested in grazing and wood-consuming industries within this territory are opposed to the maintenance of forest reserves. The greatest objection to the reserves is expressed by men concerned in grazing, and of these the sheepmen are the loudest in their denunciation. The past unlimited use of Government mountain forest land for a summer range has made it possible for a large number of settlers to engage in stock raising with little outlay for feed. The range of the foothills is sufficient from November to about the 1st of July; but high mountain forest range must be sought from July to October, during which time there is no green feed in the foothills.

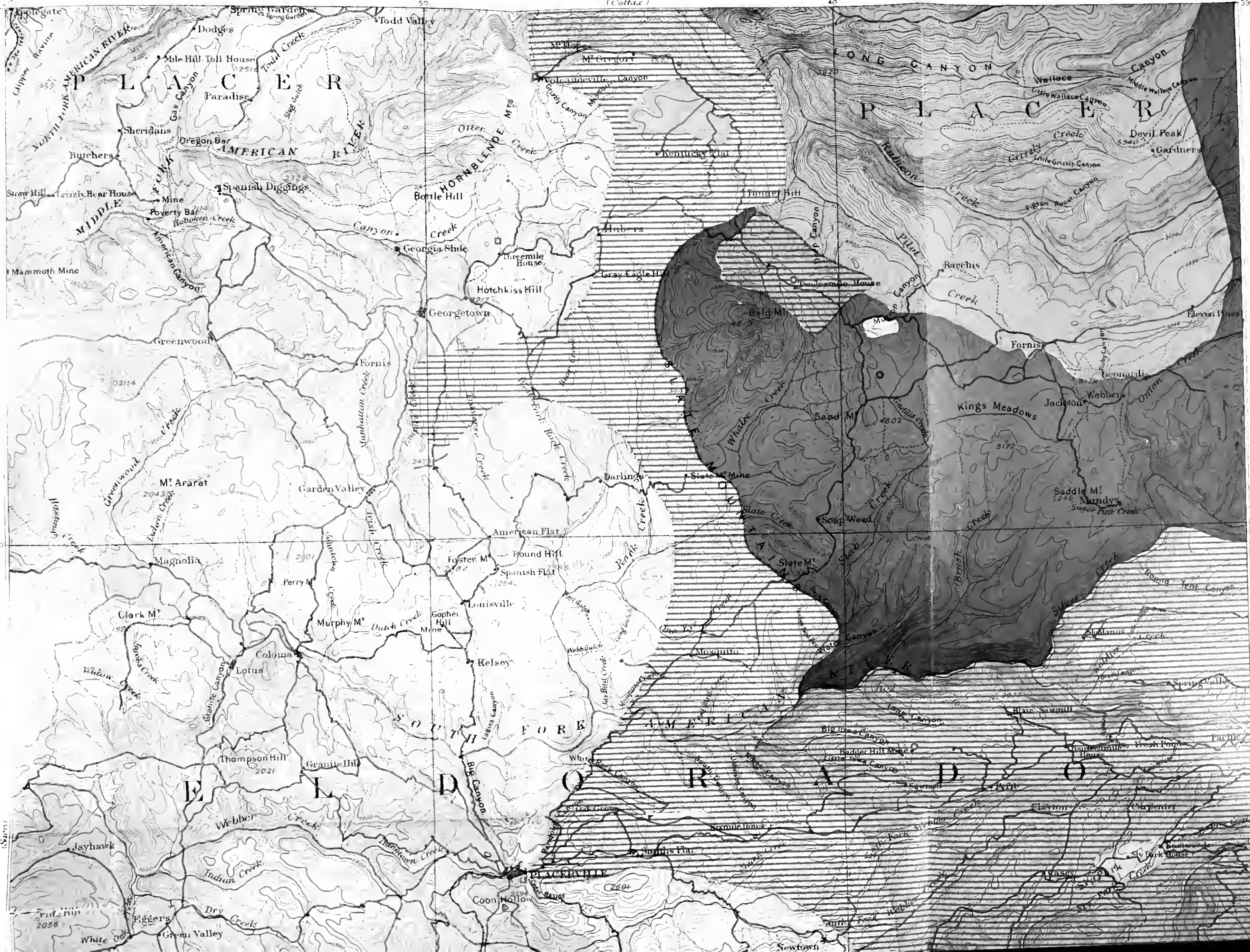
As yet the cattlemen are allowed free range in the reserves, but many of these men are opposed to maintaining the reserves, for fear that cattle may soon be excluded. Sheepmen are bitter in their denunciation of the reserve policy for the reason that they are (at least nominally) excluded from grazing in the reserves. American sheep raisers have usually respected warnings to leave the reserves, and not being able to secure sufficient range elsewhere, have, in some cases, been compelled to reduce their flocks or go out of the business entirely. These men see no public good to be derived from the reserves when grazing privileges are denied. Their permanent ranches are so distant from the high mountain watersheds that the idea of protecting water supplies is looked upon as visionary or impractical. Moreover, the fact that snow remains longer on the high, bare mountain peaks than it does in the forest below proves to these men conclusively that forests have no influence in conserving water. The general feeling is that in reserving forest land the National Government has no sympathy with the settlers, some of whom say that they shall have to leave the country if this policy continues.

Most other settlers also, not directly interested in grazing, voice the protests of stock raisers. The feeling against forest reserves expressed by settlers along the Carson Valley toll road was very bitter. However, the sheepmen pay large tolls in "driving" through this region.

U.S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT
DIRECTOR

LAND CLASSIFICATION AND DENSITY
OF STANDING TIMBER

CALIFORNIA
PLACERVILLE QUADRANGLE



LEGEND

Grazing land

Merchantable timber 5000 to 10000 feet B.M. per acre

Merchantable timber 10000 to 25000 feet B.M. per acre

Barren rock and brush land

Burned areas not restocking

Cultivable

Culled land

Cut areas restocking

Mining camps

Sawmill

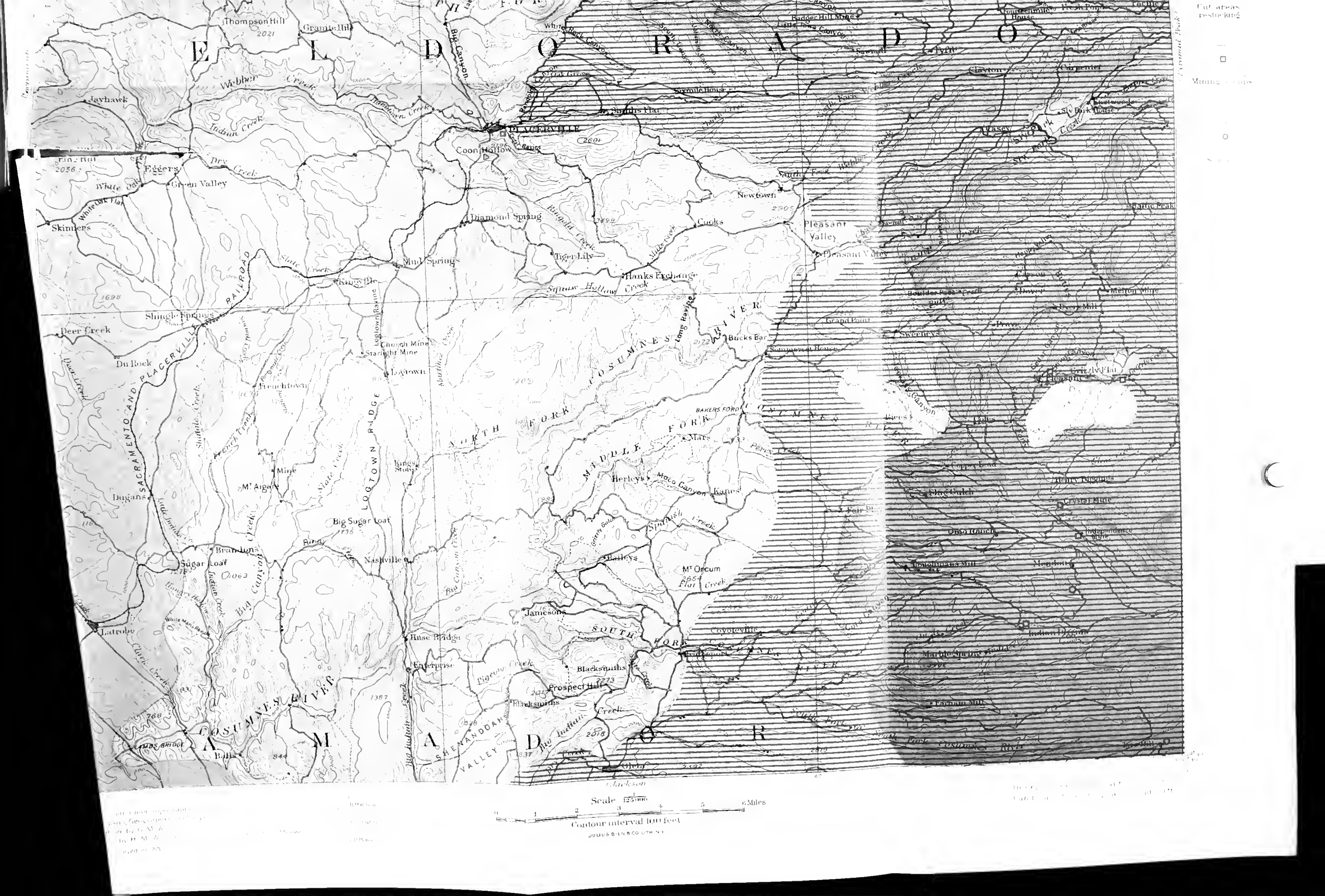
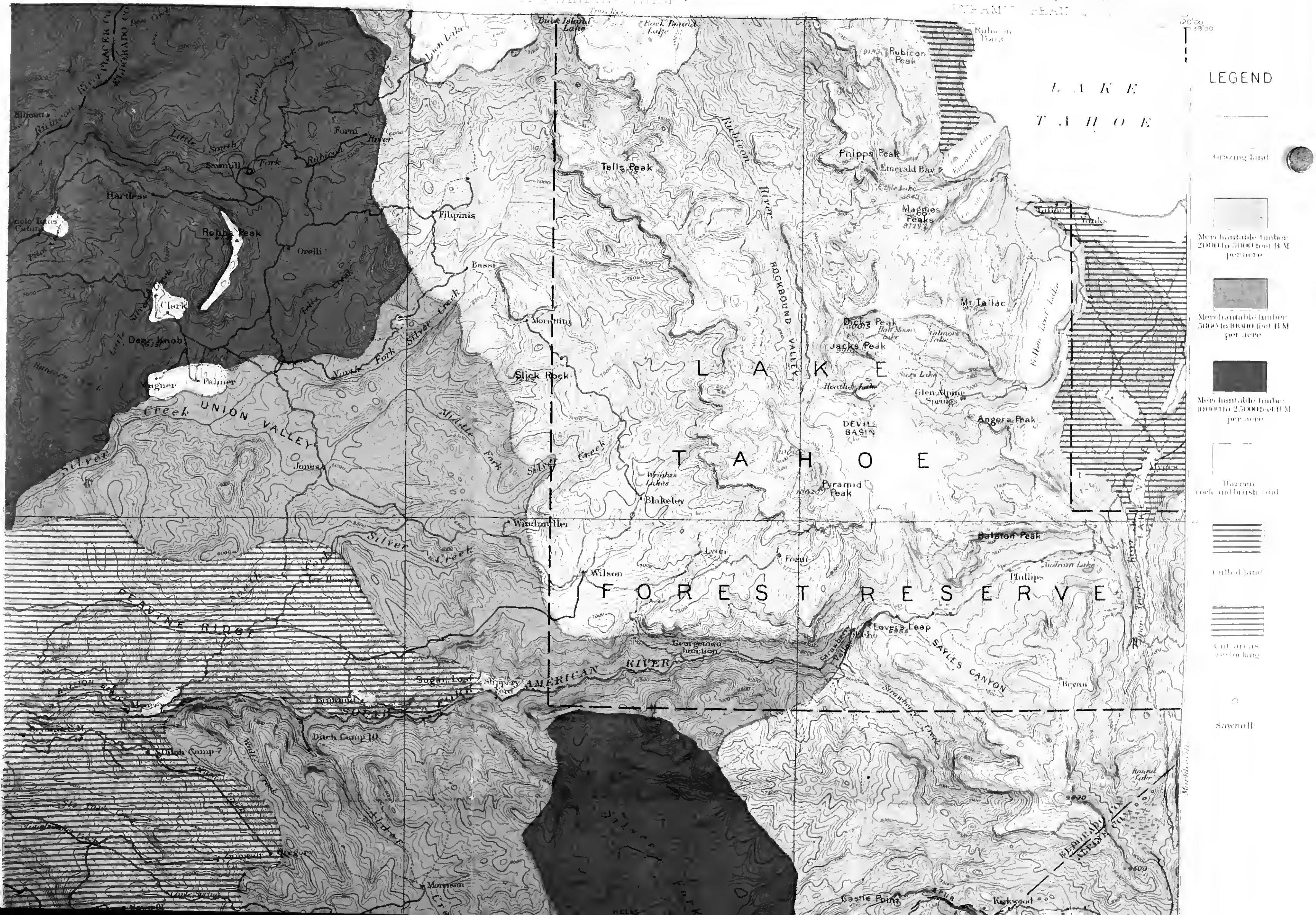

E L D O R A D O
A M A D O R
Thompson Hill
Granite Hill
Big Canyon
Webber Creek
Jayhawk
Indian Creek
Placerville
Coon Hollow
Eggers
Green Valley
White Oak Flat
Skinners
Diamond Spring
Mud Springs
Kingsville
Tiger Lily
Hanks Exchange
Squaw Hollow Creek
Newtown
Cooks
Pleasant Valley
Shingle Springs
Deer Creek
Du Rock
Sacramento and Placerville Railroad
Frenchtown
Church Mine
Starlight Mine
Logtown
Logtown Ridge
North Fork Cosumnes River
Middle Fork
South Fork
Bucks Bar
Bakers Ford
Mars
Berleys
Kanes
Mt Aguilar
Dugans
Big Sugar Loaf
Sugar Loaf
Brandons
Nashville
Baileys
Mt Ocum
Jamesons
Latrobe
Clark Creek
Cosumnes River
Base Bridge
Enterprise
Blacksmiths
Prospect Hill
Pigeon Creek
Indian Creek
Shenandoah Valley
Dry Creek
Badger Hill Mine
Clayton
Sly Park
Sixmile House
Smiths Flat
Baltic Peak
Grand Point
Sweeneys
Grizzly Flat
Copper Lead
Flag Gulch
Crystal Mine
Independence Mine
Indian Diggins
Marble Spring
Farnham Mill
Pleasant Valley
Scale 1/125000
6 Miles
Contour interval 100 feet
Julius Bien & Co. Lith. N.Y.
Cut areas restocking
Mining claims

PLATE LXXXVI



Scale $\frac{1}{125000}$

Contour interval 100 feet

JULIUS BIEN & CO. LITH. N.Y.

PLATE LXXXVII

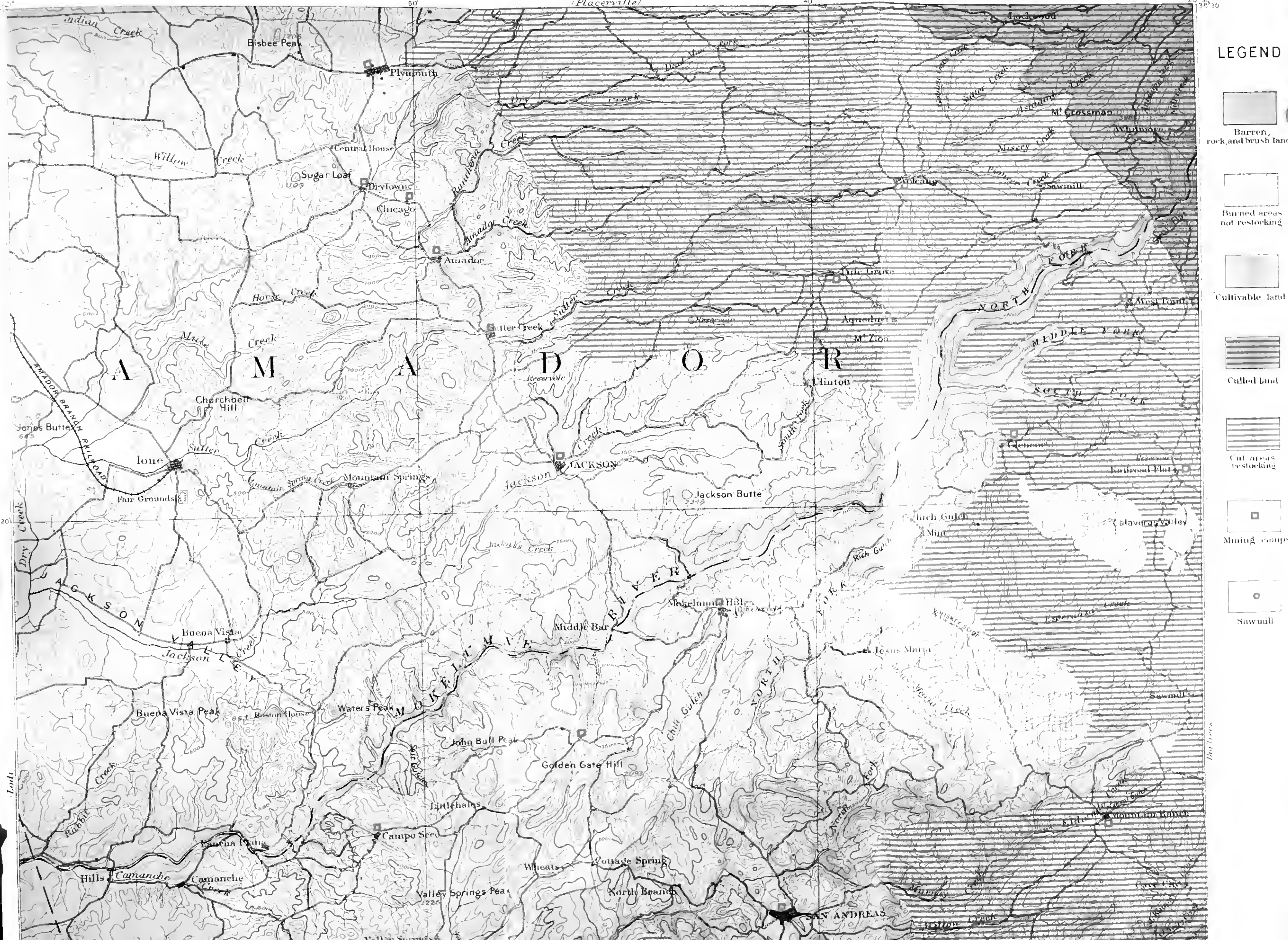
TWENTY-FIRST ANNUAL REPORT PART V

U S GEOLOGICAL SURVEY
CHARLES D WALCOTT, DIRECTOR

LAND CLASSIFICATION AND DENSITY OF STANDING TIMBER

(Placerville)

CALIFORNIA
JACKSON QUADRANGLE



Henry Gannett, Chief Geographer
A. H. Thompson, Geographer in charge
Triangulation by H. M. Wilson
Topography by A. F. Dunnington and R. H. McKee
Surveyed in 1888

Scale $\frac{1}{125000}$

Contour interval 100 feet

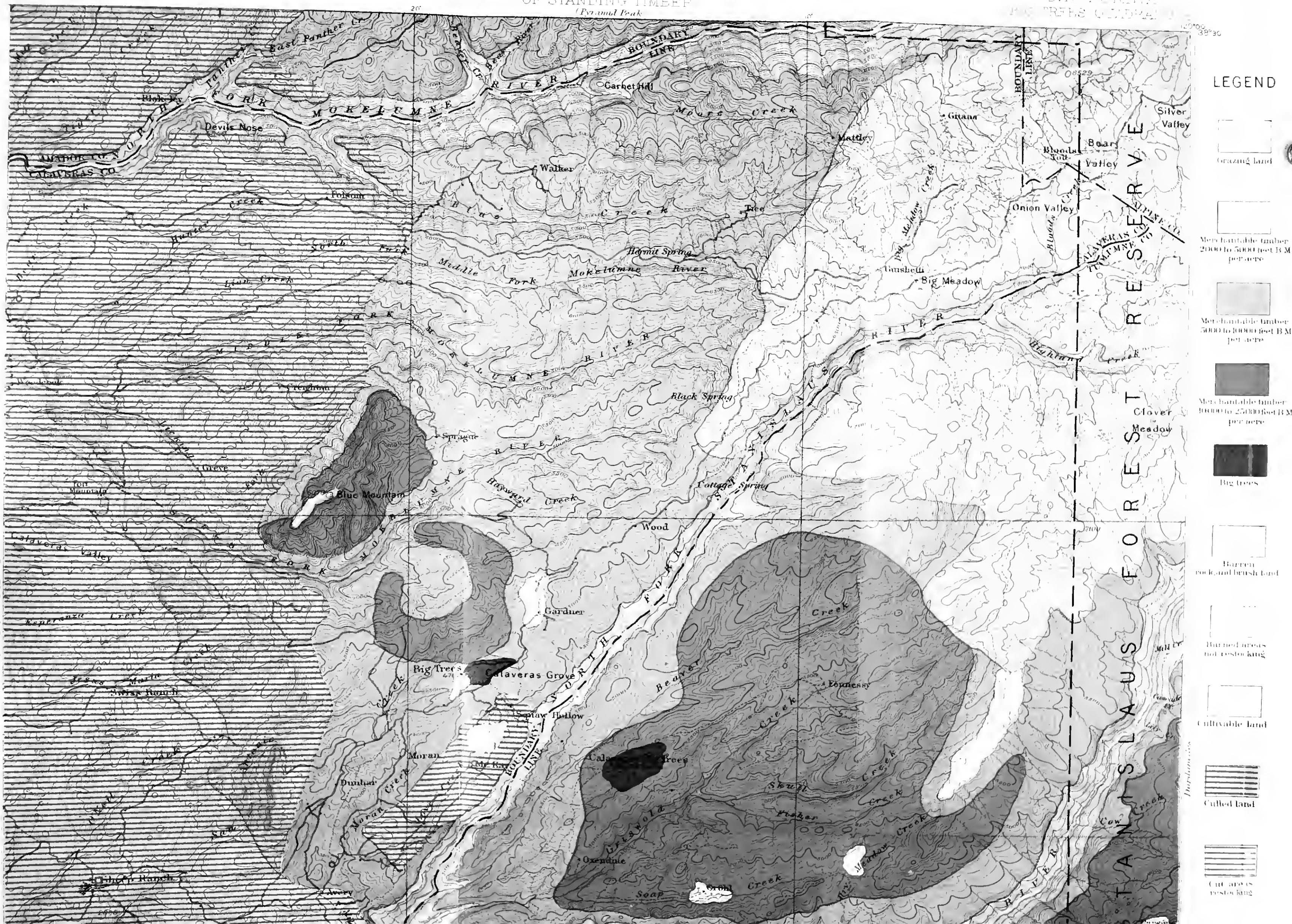
JULIUS BIEN & CO. LITH. N.Y.

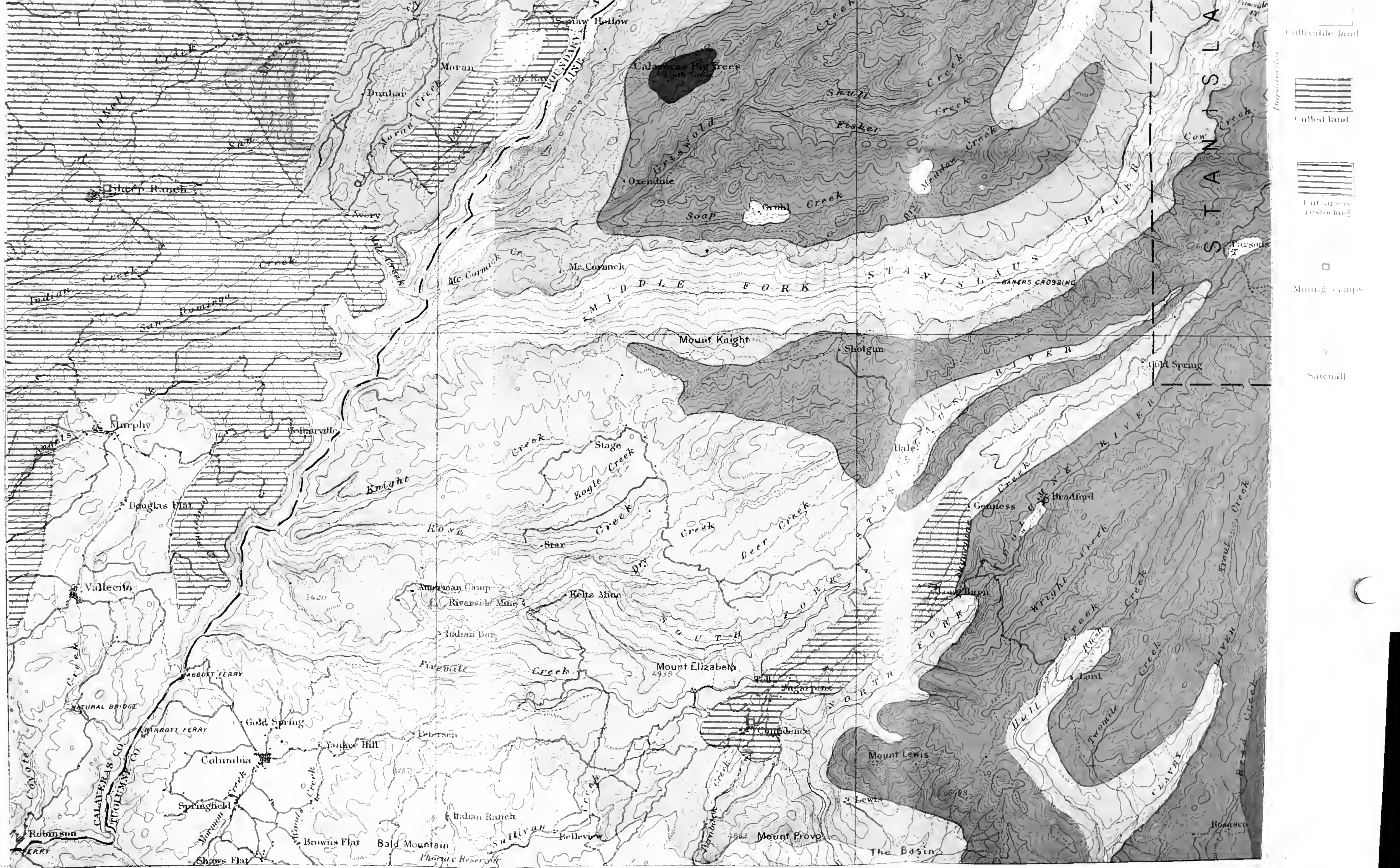
Henry Gannett, Geographer in charge
Land classification by Geo. B. Sudworth

U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT
DIRECTOR

PLATE LXXXVIII
TWENTY-FIRST ANNUAL REPORT PART V

LAND CLASSIFICATION AND DENSITY
OF STANDING TIMBER





A. H. Thompson, Geographer.
E. M. Douglas, Topographer in charge.
Triangulation by H. L. Baldwin
Topography by R. H. McKee
Surveyed in 1890-91

Scale $\frac{1}{125000}$

0 1 2 3 4 5 6 Miles

Contour interval 100 feet

Henry Gannett, Geographer in charge.
Land classification by Geo. B. Sudworth

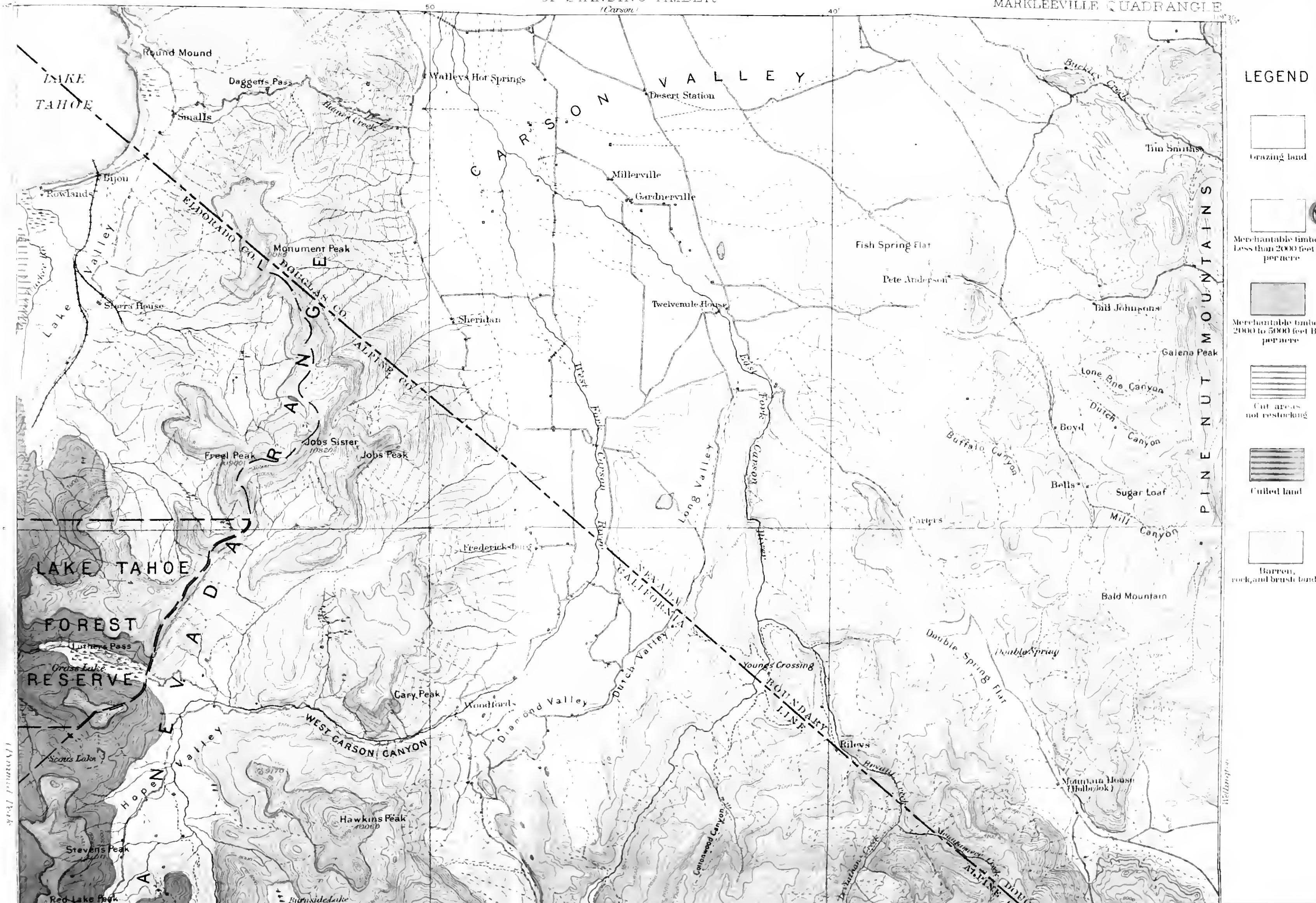
JULIUS BIEN & CO. LITH. N.Y.

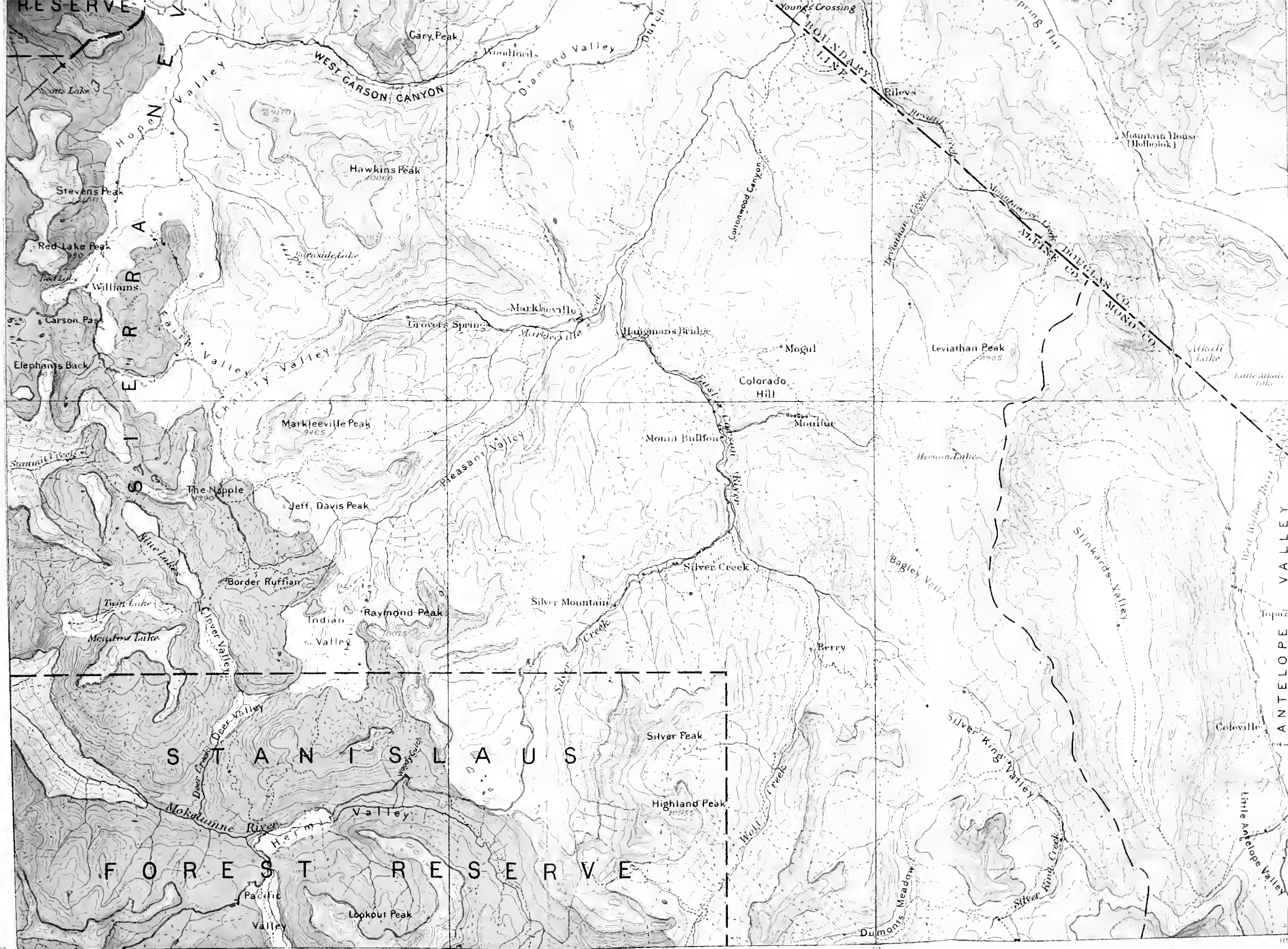
U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT
DIRECTOR

PLATE LXXXIX
TWENTY-FIRST ANNUAL REPORT PART V

LAND CLASSIFICATION AND DENSITY
OF STANDING TIMBER

CALIFORNIA-NEVADA
MARKLEEVILLE QUADRANGLE





A.H. Thompson, Geographer
E.M. Douglas, Topographer in charge
Triangulation by H.E.C. Feusier
Topography by R.H. Chapman
Surveyed in 1889

Scale $\frac{1}{125000}$
0 1 2 3 4 5 6 Miles
Contour interval 100 feet

JULIUS BIEN & CO LITH. N.Y.

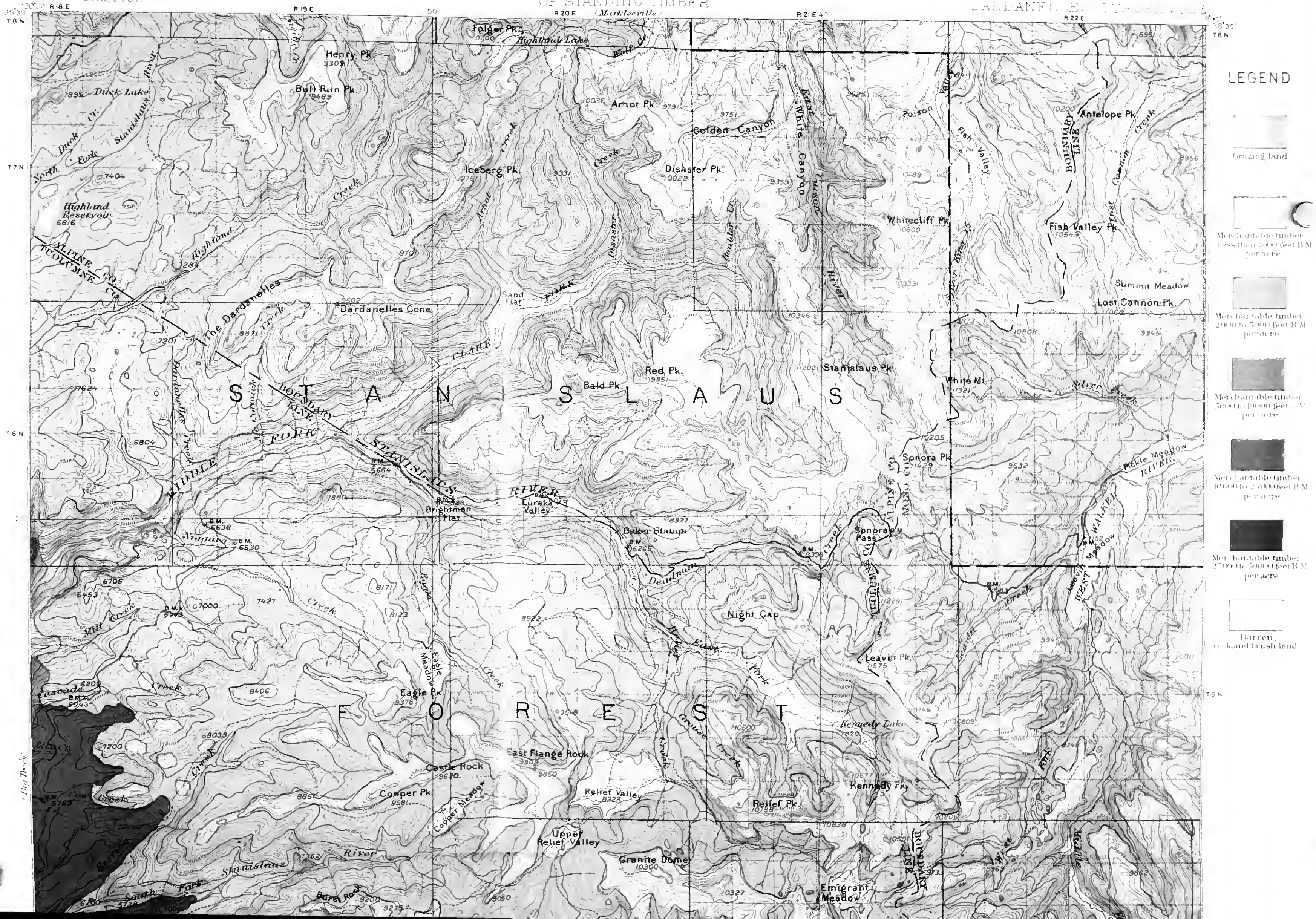
Henry Gannett Geographer in charge
Land classification by Geo B Sudworth

PLATE XC

TWENTY-FIRST ANNUAL REPORT PART V

U S GEOLOGICAL SURVEY
CHARLES D WALCOTT
DIRECTOR

LAND CLASSIFICATION AND DENSITY
OF STANDING TIMBER



R U Goode Geographer in charge
Triangulation by H E Feusier
Topography by R H McKee and R P Marshall
Surveyed in 1891-96

McK 91
Marshall 96

Scale $\frac{1}{125000}$

0 1 2 3 4 5 6 Miles

Contour interval 100 feet

JULIUS BIEN & CO. LITH. N.Y.

Henry Gannett Geographer in charge
Land classification by Geo B Sudworth