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# FOREST MANAGEMENT

(Forest Working Plans)

Guide to Lectures

Delivered at the Biltmore Forest School

By C. A. SCHENCK, Ph. D.

*Forester to the Biltmore Estate*

1907

HACKNEY & MOALE COMPANY

ASHEVILLE, NORTH CAROLINA

# CONTENTS

# FOREST MANAGEMENT

(Forest Working Plans.)

## PARAGRAPH I.

### Definitions and Introduction.

The term "forest management," used in a broad sense, comprises collectively the branches of forestry known as forest survey, forest mensuration, forest finance and forest working plans. Used in a narrow sense, the term "forest management" deals with forest working plans only and is usually defined as that branch of forestry which determines upon and regulates the sustained yield (*la possibilité*) of forests; or, by others, as a systematic arrangement of the rules by which abnormal woodlands are transformed into normal forests.

American forest management will do well to rest on a broader foundation. It should determine, in science, as well as in practice, upon the ways and means by which the desire of the owner, relative to the use of a forest (for revenue, timber supply, shelter, pasture, ornament, water protection, game preserves, etc.) can be best accomplished. In the majority of cases the owner desires to draw from the forest the largest possible revenue. As a consequence American forest management will have to deal usually with the various means by which given forestal investments can be developed in a manner producing the highest dividends in the long run.

In Europe financial considerations are rarely applied to forest management. Since 1871, however, the adherents of John Frederic Judeich insist that forest management (like farm management, railroad management and any other business management) should see its goal in a strife for the highest rate of interest obtainable from all productive capital engaged in the forest.

The owners of forests (like the owners of farms, mines. hotels, railroad stocks) cannot be expected to seek any other managerial end in the administration of their property.

The rapidity of any development depends (in forests, farms, mines, perhaps in all investments), pre-eminently on the owner's financial ability to make desirable moves at the most desirable time.

In many instances development is possibly only with the help of money borrowed by the owner. Borrowed money (mortgages, bonds) usually proves a curse to the owner of forests after the lapse of a few years. His policy of development is handcuffed by the necessity of meeting the indebtedness, year in and year out, irrespective of market conditions and labor conditions. Forestry, in such cases, must be destructive. It must pay the bonds as they mature out of the substance of the forest.

Frequently forest destruction promises better dividends than forest maintenance. In such cases a forest working plan resolves itself into a plan covering the various operations commonly known as destructive lumbering. The soil may be cleared because it is thought to be valuable as farm soil, pasture soil, orchard soil; or the land may be abandoned after lumbering as worthless when the owner believes that the taxes due on the cleared land (taken together with the expenses of protecting a second growth expectable on the cleared land) form a new investment of an unpromising nature.

Forests cannot be well developed where the development of the whole country is in arrears. Here the owner is compelled to adopt a policy of waiting—waiting for that general development of the country which is sure permanently to improve the value of stumpage. In such cases a working plan resolves itself into a plan for forest protection (against squatters, fires, etc.)

In the prairies and also in the East, the land owner is frequently inclined—on a small scale, usually—to improve the condition of his property sylviculturally, making investments for afforestation, cleaning, weeding, etc. In such cases a forest working plan resolves itself, essentially, into a plan covering various sylvicultural operations (constructive forestry).

In Germany and France, at the time being, conservative forestry produces invariably financial results superior to those of de-forestation and of abandonment of cut over woodland. In these countries cut over woodland unfit for the plow (known as absolute forest land), has a value usually exceeding $10 per acre.

Modern European foresters are in the habit of identifying the term "management" with the term "conservative management" of forests; and all European forest working plans provide for conservative working of the forest.

# CHAPTER I—THE IDEAL FOREST

In an ideal forest continuously supplying certain mills or certain markets with an equal annual amount of timber or wood there should be at hand:

A normal gradation of the age classes (¶ II);
A normal growing stock (¶ III);
A normal increment (¶ IV).

No forest ever has been, is, or ever will be "ideal." The ideal forest deserves attention only in theory. Its theory deals with volumes instead of dealing with values.

## PARAGRAPH II.

### NORMAL GRADATION OF AGE CLASSES.

A normal gradation of age classes is literally at hand in the forest when there are found as many age classes as the rotation comprises years. Each class has an age differing from that of any other class. The youngest class is one year old; the next class is two years old; the third class is three years old, and so on to the oldest class the age of which equals the rotation.

In the case of natural seed regeneration, the normal number of age classes at hand is expressed by the fraction

$$\frac{r}{s}$$

wherein r stands for rotation, and wherein s stands for the number of years normally elapsing between successive seed years. Since a single seed year is rarely sufficient to secure a complete stand of seedlings, a wood raised by natural seed regeneration is usually composed of two, three or more age classes appearing in mixture and forming distinct aggregates.

Where the rotation comprises 100 years, and where the period of regeneration comprises 20 years, and where seed years occur every 5 years, there a "normal gradation of age classes" contains, in the fall succeeding a seed year, the following aggregate of age classes:

| | | | | |
|---|---|---|---|---|
| Youngest aggregate............ | 1 | 6 | 11 | and 16 years old |
| Second " ............ | 21 | 26 | 31 | " 36 " " |
| Third " ............ | 41 | 46 | 51 | " 56 " " |
| Fourth " ............ | 61 | 66 | 71 | " 76 " " |
| Oldest " ............ | 81 | 86 | 91 | " 96 " " |

OR THE FOLLOWING AGGREGATES:

| | | | | |
|---|---|---|---|---|
| Youngest aggregate............ | 6 | 11 | 16 | and 21 years old |
| Second " ............ | 26 | 31 | 36 | " 41 " " |
| Third " ............ | 46 | 51 | 56 | " 61 " " |
| Fourth " ............ | 66 | 71 | 76 | " 81 " " |
| Oldest " ............ | 86 | 91 | 96 | " 101 " " |

OR THE FOLLOWING AGGREGATES:

| | | | | |
|---|---|---|---|---|
| Youngest aggregate............ | 11 | 16 | 21 | and 26 years old |
| Second " ............ | 31 | 36 | 41 | " 46 " " |
| Third " ............ | 51 | 56 | 61 | " 66 " " |
| Fourth " ............ | 71 | 76 | 81 | " 86 " " |
| Oldest " ............ | 91 | 96 | 101 | " 106 " " |

OR THE FOLLOWING AGGREGATES:

| | | | | |
|---|---|---|---|---|
| Youngest aggregate............ | 16 | 21 | 26 | and 31 years old |
| Second " ............ | 36 | 41 | 46 | " 51 " " |
| Third " ............ | 56 | 61 | 66 | " 71 " " |
| Fourth " ............ | 76 | 81 | 86 | " 91 " " |
| Oldest " ............ | 96 | 101 | 106 | " lacking |

Amongst all age classes under 21 years old, some mother trees are still at hand up to 110 years old; and beneath all age classes over 90 years old, some seedlings are found up to 20 years old.

In the ideal selection forest, all age classes are represented on every acre of ground.

The separation of the age classes (allotting to each age class separate areas) facilitates logging and transportation; it increases, on the other hand, the dangers threatening the forests.

If a proper gradation of age classes exists in a forest it does not necessarily follow that the age classes are properly grouped and arranged in "cutting series." By "proper cutting series" is understood a number of adjoining age classes, sloping roof-like from the older to the younger, toward the windward side. If the cutting series are improper, then sacrifices must be made, hypermature wood must be left, and immature wood must be cut unless the mistake originally at hand is allowed to be perpetuated. In the latter case, the losses of the future are apt to be greater than the sacrifices voluntarily made with a view to the establishment of proper cutting series. Cutting series must be isolated one from the other, if need be, by "severance cuttings."

## PARAGRAPH III.

### NORMAL GROWING STOCK.

The normal growing stock is at hand where the age gradation of the various woods composing the forest and their respective volumes are normal. A forest, however, might have the normal volume without having the normal age gradation, when a deficiency of one age class is offset by a surplus in another age class. The normal growing stock, during summer, has the volume

$$\frac{r^2 \times i}{2}$$

wherein r represents the rotation, and i the average annual increment of a mature age class.

Illustration: A spruce forest covers 2,000 acres. The rotation is 100 years. The mature wood, 100 years old, contains normally 120 cords per acre. Under these conditions, the area of an age class is 20 acres; the average annual increment of the mature age class is 24 cords; and the normal growing stock is

$$\frac{100 \times 100 \times 24}{2} = 120{,}000 \text{ cords.}$$

The volume of poles and trees predestined to be cut and removed prior to maturity (by way of thinnings) is not included in the volume given by the formula.

Whilst one normal growing stock is removed, in the course of a rotation, another normal growing stock—its exact counterpart—is raised on the very same area.

If the original growing stock is abnormally deficient, the foresters, by cutting less than the increment of the forest and thus adding to the original volume, may succeed in gradually establishing the "normal growing stock."

Normality of the growing stock is that condition required in an "ideal forest," which the foresters would find it rather easy to provide. In the virgin woods, frequently the actual growing stock is larger than the normal growing stock, owing to the preponderance of mature and hypermature age classes.

## PARAGRAPH IV.

### NORMAL INCREMENT.

The normal wood at the age of maturity has imbedded in itself the increments of a wood, one, two, three, etc., years old; consequently, it represents all of the increments taking place annually over the entire area of a normal forest containing the age classes, one, two, three, etc. Since only a few trees, however, reach maturity a rule fails to be entirely correct which reads: "The normal increment of a forest equals the normal volume of its oldest age class."

Generally speaking, since the same causes must have the same effect, the actual increment, in tons of wood fibre, normally formed on an acre of ground, fully stocked, depends solely on climate and soil, wood fibre being "solidified atmosphere." The forester's aim should be to concentrate the increment into the smallest number of trees, without losing any increment, so as to grow the biggest logs in the shortest rotation.

In America, soil is cheap; hence there seems to be no need to force every square inch of soil into the harness of tree production. We should keep in mind, however,—

1. That woods poorly stocked are apt to yield knotty timber;
2. That the outlay for taxes, protection and administration depends more on area than on density of stand;
3. That the logging expenses per 1,000 feet b. m. are small where the stumpage is heavy;
4. That investments for roads and other permanent improvements, per 1,000 feet b. m., are relatively small in well stocked forests;
5. That the fertility of forest soil suffers under a loose canopy overhead.

The main sylvicultural measures leading to a normal increment are:

Weeding.
Improvement cutting.
Thinning.
Afforestation.
Reinforcing.

## PARAGRAPH V.

### FINANCIAL CONSIDERATIONS.

Three kinds of increment compose the latent gross revenue obtainable from any wood which is left to itself or which is placed under forestal care:

1. The quantity increment, depending solely on the amount of wood fibre formed.

2. The quality increment, depending solely on the difference of price shown in the same year by logs of different diameters, per unit of contents.

3. The price increment, depending solely on the difference of value which the same log will exhibit in different years. This latter increment is influenced by increase of population and wealth, cheapened facilities of transportation, exhaustion of the virgin woods, and declining purchasing power of gold.

As an illustration of price increment, the following figures may be of interest:

Wholesale Prices of Yellow Poplar, 4-4 Lumber,
at Biltmore, N. C.

| Quality. | In 1896. | In 1907. |
|---|---|---|
| fas. | $21.00 | $43.00 to $52.00 |
| saps | 16.00 | 33.00 |
| C. 1 | 12.00 | 28.00 |
| C. 2 | 6.50 | 16.00 |

The expense of production, with modern mills and improved transportation, is as high in 1907 as it was in 1896, viz.: $9 per 1,000 feet b. m. Assuming that certain trees have turned out 25 per cent. of fas, 25 per cent. saps, 25 per cent. C. 1 and 25 per cent. C. 2, the stumpage values of such trees was per 1,000 feet b. m.

in 1896 .......................................... $ 5.00
in 1907 .......................................... $22.00

and has increased, consequently, at the rate of 30 per cent. (simple interest, equalling 14 per cent. of compound interest) per annum.

The increase in the value of many other forest products has been similarly phenomenal; and the question arises: Why is the owner of forests unwise enough to reduce this stumpage as long as the rise continues to be phenomenal,—in excess of any dividend derivable from other investments? The answer frequently lies in three words:

Poverty;
Impatience;
Ignorance.

The enormous increase of gold production during the last 20 years promises to continue and to become more phenomenal. The director of the U. S. Mint reports (in 1904, p. 41) that the rise of wages does not act as an automatic check to gold production, and that the tendency of the expense of gold production continues to be downward. The effect of increasing gold supplies on commodity prices, wages, land values, mortgages, bonds, etc., is easily perceived:

The owner of bonds and mortgages sinks to a lower level of revenue; whilst the owner of forests and farms remains (at least) equally wealthy.

The question will be asked, naturally: Does it pay to strive towards the establishment of an "ideal forest" . . . . towards the establishment of an impossibility?

European foresters are apt to answer the question by an emphatic "Yes."

The American forester might consider, before answering, four points:

(1) The great variety of conditions existing in the various sections of the various states from which the financial prospects of conservative forestry depend.

(2) The fact that conservatism in the forest cannot be expected, in the long run, to be as remunerative in this country as it is abroad unless the forest is rendered as safe as the German forests from fire, taxes and whimsical legislation.

(3) The fact that an ideal forest represents a large investment yielding a small rate of surplus revenue.

(4) The possibility that a forest now considered "ideal" as to rotation, composition, species, roads and so on, is apt to be considered deficient when the lapse of years has caused a change of the economical conditions surrounding the forest.

As long as our country develops by leaps and bounds, as long as the immediate future of our forests is dark, as long as other investments seem safer, simpler, better than forestal investments, the time has not arrived to strive toward "ideal forests."

The American forester can consider the forest only as "so much money invested." *That* forest is ideal which can be expected to yield, for a long time and perhaps forever, a safe, steady and high dividend on every dollar invested. In such a forest, the various items of value (as trees, soil, roads, sawmills) appear as proper shares of the aggregate value.

The following may serve as an illustration:

| | | |
|---|---|---|
| Value of stumpage, per acre............ | \$7.75, or 77½ | per cent. |
| Value of soil, " " ............ | 1.00, or 10 | per cent. |
| Value of roads, " " ............ | .50, or 5 | per cent. |
| Value of sawmills, " " ............ | .75, or 7½ | per cent. |
| Total investment.................. | \$10.00, or 100 | per cent. |

The form of the ideal revenue depends on the owner's wish. The owner may or may not prefer an annual revenue of 40 cents per acre, obtained without decreasing the value of the stumpage, to a revenue of \$2.00, exhausting the forest in a dozen years. The owner alone can decide whether a dividend is safe enough, steady enough and high enough; his decision is based, naturally, on a comparison between forest revenue and revenues obtainable from other investments.

The investor stakes his money on that enterprise in which he has the greatest confidence; and it is usual that the farmer puts his money in farms; the miner in mines; the railroad man in railroad stock; and the lumberman in forests, The American lumberman is apt to consider investments in forestry (be it destructive or conservative) as ideal investments; outsiders are not prone to share his view.

As long as this country abounds in merchantable woods, the lumberman has an easy chance, after exhausting the stumpage on a given tract completely, to shift his capital to another tract, purchasing the stumpage thereon out of the moneys obtained by his operations conducted on the preceding tract. Usually, he prefers, for obvious reasons, the purchase of timber to the purchase of the forest in fee simple. Under such conditions, the lumberman *cannot* be interested in the production of second growth, nor in operations merely withdrawing trees working at a small rate of revenue.

The owners of the fee simple—farmers, townsfolks, aliens—do not command any knowledge of forest investments; having paid the taxes on the land for a number of years without any returns, they embrace readily the first chance at obtaining "big returns." These big returns usually exceed the price by far at which the land was bought. Nevertheless, and just as usually, such "big returns" are a mere pittance.

The Forest Service of the United States has before it an enormous task: the task of proving to the owners of woodlands, who are ignorant of present and of prospective values of timber, the advisability of conservative lumbering.

Unfortunately, there do not exist anywhere associations of forest owners through which the members might be enlightened.

## PARAGRAPH VI.

### SUSTAINED YIELD ("POSSIBILITY").

Normally, the "sustained yield" of the forest is that number of cubic feet of wood which nature produces in the forest annually; the annual removal of this number of cubic feet does not decrease the original amount of stumpage. The normal sustained yield equals the annual surplusage of production.

The cutting of a sustained yield—no more, no less—is indicated wherever the capacity of the market is limited, a condition which we meet almost invariably on the fuel market. In Germany, two-thirds of the annual increment of all forests consists of fuel wood. In America, the requirements of expensive, non-movable plants (tanneries, pulp mills, mines) are in the direction of a sustained yield.

When all merchantable trees have been removed from a forest, a sustained yield can not be obtained any more. Before touching the primeval forest, the owner must decide whether or not conservative forestry, whether or not a sustained yield is indicated.

Primeval woods containing a large number of idling and decaying trees should not be worked for a sustained yield.

It should never be forgotten that there is a vast difference between the term "merchantable trees," and the term "mature trees." Merchantable trees are very often far from being mature; and mature trees have often ceased to be—or are not—merchantable.

An equal annual yield offers to the lumberjack the advantage of equal and steady employment in one and the same forest or at one and the same mill.

An equal annual yield offers to the owner approximately equal annual dividends.

Where no yield is obtainable for a long series of years, there the outlay for taxes, protection and administration will accumulate at a rate deterring the owner from any attempt at conservatism.

The disadvantages of a sustained yield where it binds the forester in iron chains, are:

1. It is impossible to take advantage of boom prices.

2. It is necessary to cut in years of panic.

3. Trees without increment are left uncut; trees of good increment are cut where the yield is strictly sustained. Similarly, needful thinnings are often postponed; or in other cases conducted with excessive severity.

4. Valuable young growth is often left under severe pressure overhead; or in other cases prematurely exposed.

5. Seed years are not used to full advantage.

The normal possibility, from the economic standpoint, cannot be expressed by volume; it must be expressed in dollars and cents. It is that sum of money which yields annually the expected or desired interest on all capitals engaged in the forestal production. In other words, it is the yield of a forest when in financial equilibrium. In that case, no wood works at a lesser rate than at the proper indicating percentage adequate to its age.

## PARAGRAPH VII.

### UTILIZATION PERCENTAGE.

The ratio between annual cut and stumpage at hand reads, in the normal forest:—

$$\frac{\text{sustained yield}}{\text{normal growing stock}} = \frac{r\ i}{\frac{r^2\ i}{2}} = \frac{2}{r}. \quad \text{The factor } \frac{2}{r}$$

is called the utilization percentage. It expresses the fact that a short rotation allows, when the growing stock is given, of a larger possibility than a long rotation. Short rotations are handicapped by silvicultural drawbacks and the production of small trees only, the demand for which is restricted (firewood, spokes, axe-handles and railroad ties). The utilization percentage, since it is the ratio of volumes only, has little economic importance.

# CHAPTER II—SUBDIVISIONS OF A FOREST

The subdivision of a forest into minor units of management is based on local conditions and on local needs.

A large forest is usually subdivided into
Working circles (¶ VIII).
Working sections (¶ IX).
Compartments and blocks (¶ X).

## PARAGRAPH VIII.

### WORKING CIRCLES.

Under "working circles" we understand, after Schlich, that forest area owned by one person or company which is much under the provision of one and the same principal working plan.

## PARAGRAPH IX.

### WORKING SECTIONS.

In large working circles, the economic conditions are frequently such as not to allow of uniting all woods under one cutting plan. Woods growing under more or less equal conditions and exhibiting equal silvics are allotted to distinct working sections, to be dealt with independently from all others. A working section should comprise woods of all ages and classes, and should consist of several cutting series. There is no need for the working section to cover a coherent area. For each working section in Europe, the financial possibility is ascertained separately. The following moments may necessitate the formation of a working section:—

1. Different species.
2. Different silvicultural requirements.
3. Different rotation.
4. Different laws.
5. Different means of transportation.
6. Different locality.

A large number of working sections complicates forest administration.

## PARAGRAPH X.

### COMPARTMENTS AND BLOCKS.

The leading foresters do not agree with regard to a proper definition of the term "compartment." For the majority of foresters, a compartment is a "unit of silvicultural treatment." The compartment may contain sub-compartments consisting of smaller or larger groups which, to speak with the advocates of that definition, should be eliminated by purification of the compartments. Others maintain that the compartment should designate merely a geographical unit of the forest used to describe, in instructions, reports and records, the exact locality at which a certain act is to be or has been performed.

The boundary lines of geographic compartments should be natural lines (ridges, creeks and slopes) as much as possible, and not artificial lines (survey lanes and roads). The size of the compartment depends entirely on local economic conditions. High timber prices and intensive management invite the formation of small compartments.

Several adjoining compartments are allotted to a "block;" for instance, the compartments on a certain mountain or beyond a certain creek. In some cases, each block has a separate series of compartment numbers, each series beginning with "one." A block may be composed of compartments belonging to different working sections.

Under extensive management, a block might be formed by the area drained by an entire river system; and the compartments composing it might be designated by the names of the creeks traversing them.

# CHAPTER III—WORKING PLAN REPORTS

The term "working plan" is a misnomer. The "working plan" is a report more on facts than on proposed schemes.

The meaning of the term is somewhat indistinct. It might represent one or the other of the three following statements:

1. The chief (principal) working plan, extending over a large number of years (a whole rotation, or the time of installation).

2. The periodic working plan, extending over 10, 20 or 24 years usually.

3. The annual working plan, forming a mere annual budget.

In many cases, the principal working plan is simultaneously used as a periodic working plan.

## PARAGRAPH XI.

### THE CHIEF WORKING PLAN.

The chief working plan is called by Schlich. more properly, "chief working plan report," and contains the following three parts:

1. A statement of facts based on stock taking.

2. The desire of the owner regarding the purpose of forest management.

3. The plan proper, containing the forester's advice as submitted to the owner, discussed with the owner and approved by the owner.

The plan proper is, usually, a compromise between owner and forester.

The chief working plan requires revision and is invariably re-drawn *before* the lapse of many years whenever the facts are altered on which the plan was based.

The subheads of a chief working plan [under the chapters "facts," "desire of the owner," "plan"] are:

Forest survey (¶ XII).
Description of locality (¶ XIII).
Yield tables and volume tables (¶ XIV).
Problems of silviculture and of protection (¶ XV).
Forest utilization (¶ XVI).
Forestal investments (¶ XVII).

All data ascertained and all changes planned should be shown, if possible, on maps allowing of rapid reference.

The scale and the detail of the maps depend on the value of the investment per acre.

## PARAGRAPH XII.

### FOREST SURVEY.

The objects of a forest survey are:—

1. Outside boundaries and those of interior holdings.

2. Railroads, rivers, creeks, bluffs and other obstacles, and means of transportation.

3. Lines between localities having different laws, inasmuch as they influence forest management.

4. Differences in ownership.

5. Boundaries of the various forest ranges.

6. Configuration.

7. Differences of soil; mineral possibilities.

8. Dividing lines between forest soil, farm soil, pasture soil, and mineral soil.

9. Lines of working circles, if there are any.

10. Roads, trails, and fire-lanes.

11. Age, species, and quality of growing stock, according to compartments.

It is not necessary, of course, that all of these points should be exhibited in all working plants.

## PARAGRAPH XIII.

### DESCRIPTION OF LOCALITY.

The "locality" is usually described by compartments. The "quality of the locality," which means to say its productiveness, is a function of soil and climate.

The height growth of the trees yields the best indication of the quality of the locality. The number of qualities of locality distinguished in a chief working plan depends on local conditions,—notably on the intensity of management.

## PARAGRAPH XIV.

### YIELD TABLES AND VOLUME TABLES.

Yield tables are required for a forecast of future timber crops. In America, tree growth tables (volume tables) must frequently take the place of yield tables.

Yield tables and volume tables show the interdependence between soil, age, diameter and volume. It is wise to show the development of the value of a tree as well, with a view of determining the age of maturity. A tree is mature when the annual quantity, quality, and price increment ceases to yield a sufficient rate of interest on the stumpage value of the tree.

## PARAGRAPH XV.

### PROBLEMS OF SILVICULTURE AND OF PROTECTION.

Wherever local conditions allow of it, the chief working plan dwells at length upon the silvicultural system to be adopted for the various working sections. The method of regeneration, the species to be favored, the extent of improvement cuttings, the method of weeding and the financial effect of these measures must be shown. The extent and advisability of forest pasture, turpentine or sugar industry, game preservation, landscape considerations, etc., must be touched.

Silvicultural investments are unwise where the forest can not be protected from fires. The financial outlook of investments in first growth is better than the financial outlook of investments in second growth wheresoever the restriction and the control of fires is difficult.

The chief working plan describes the existing and the proposed means of protection from forest fires, detailing the outlay to be incurred on that score.

Continuous employment of workmen in all parts of the forest, year in and year out, together with ready access to all parts of the forest, are the surest means of fire protection.

## PARAGRAPH XVI.

### FOREST UTILIZATION.

For many a year to come, the major part of the work to be planned and to be done by the American forester must consist in the utilization of the forest (lumbering). The forester is essentially a lumberman.

The working plan considers the most advisable way of transforming into money the various raw products of the forest. It discusses the financial effect of the various methods of logging (animal power versus steam power), of the various mills (portable, circular, band, etc.)

The degree in which the owner (through the forester) attends to the removal and to the refinement of his timber products is controlled by local as well as by personal conditions. The owner might offer for sale stumpage, or logs yarded, or rough lumber, or refined lumber.

As long as there are more owners of timber land than manufacturers of lumber, the stumpage market is a buyer's market; and the owner of forests does well to engage in manufacturing enterprises.

Of the utmost importance is a careful study of the means of transportation (water, rail, flumes, etc.) The forester should never forget that lumbering—and consequently forestry—is essentially a problem of transportation.

The expense to be incurred for permanent and for temporary means of transportation requires careful discussion. In conservative forestry, the main arteries of transportation, necessarily, have a permanent character. The combination of the means of transportation to be adopted (railroads, narrow or standard; cables; water-courses; flumes; wagon roads) depends on local circumstances. Public roads and railroads, advisable alterations, charters to be secured from the legislature are topics requiring attention. The plan of transportation is explained by a map showing the existing and the proposed lines of transportation.

## PARAGRAPH XVII.

### FORESTAL INVESTMENTS.

In the United States, no private activity having the forest for its object (*id est*, any forestry in a broad sense), is conceivable which does not mean to result in good financial returns. Forestry is business, and in business there is no room for sentiment. That forestry must be considered best, which pays best.

Compared with other investments in realties (e. g., farms, mines, houses), forest investments show several undesirable features. They are difficult of control; they fail continuously to yield annual cash dividends; they are endangered by fires and cannot be insured against destruction; their products are not as absolutely indispensable to mankind as farm products, mine products or the shelter of a house; subdivision, joint ownership, sale in fee are difficult to arrange; mortgages or bonds on forests are hard to secure, and theft of timber is hard to prevent.

There are, on the other hand, many factors speaking in favor of forest investments: Notably the phenomenal increase in the value of timber brought about by an increase in population and continuous prosperity; the certainty of wood production, year in and year out, with which fires only can interfere; the strong possibility of more extended use of wood products in the manufacture of paper, packages, yarns, alcohol, sugar and food stuffs; the fact that the forest stores its own products away, free of charge, until it may please the owner to place them on the market; the rapid advance in the value of soil, etc.

According to the location of the forest and in a higher degree, according to species of trees and age of trees, the disadvantages connected with forest investments vary from case to case. They seem to weigh heavily on a second growth which yields no dividend whatever, is seriously endangered by fire, contains assets of prospective value only and offers no chance at extraordinary results. There exist in the United States enormous areas covered with second growth forests: What sense can there be, consequently, in investments tending to produce still more second growth?

It is obvious that the chances of first growth to be remunerative are, generally speaking, very good. This first growth does not increase in volume, the death rate of timber offsetting the birth rate; its increase in value, however, is certain; heavy logs are getting scarce,—and they alone furnish lumber commanding the highest price; the degree to which the trees are utilized without waste increases from year to year; the difficulties of transportation are declining continuously. Is it to be wondered at, then, that many investors—and notably all lumbermen—are eager to invest in first growth whilst utterly unwilling to stake their money on second growth?

The question might be asked: Why are the owners reluctant to practice "conservative lumbering," a modus of logging which tends to secure the maximum sum total formed of net present returns and prospective values left? To take an illustration from the South: Why does the owner insist on cutting every pine making a log of over 6 inches at the small end? Why does he refuse to leave all trees having a diameter under 20 inches and yielding over 7 per cent. of latent annual interest?

The explanation lies in the following points:

1. No seer can actually foretell the latent annual interest which trees of various diameters will yield in the immediate and in the more distant future. The forest dividend consists largely of price increment; the price increment of big trees is (veneer business!) particularly good. There is little financial advantage in the utilization of big trees (if they are sound), as long as an annual price increment of 10 per cent. and more can be counted upon. A big tree having a stumpage value of $12.00 per 1,000 feet b. m. is not mature *per se*. The fine poplars, oaks and chestnuts of the Southland must be considered immature, since their value is absolutely sure to increase at an annual rate of over 10 per cent.

The assumption of the principle is wrong, it seems, that conservative lumbering should leave the smaller trees and remove the big trees; or that maturity can be determined by diameter limits.

The owner of woodlands (and the forester) can only venture a forecast, guessing at the future condition of the lumber market; big trees have—to say the least—the same chance with small trees to be money makers. And it is natural that the owner is inclined to either remove or to leave *all* of his trees.

2. Let us suppose that the owner leaves in the course of lumbering all trees having under 18 inches diameter representing a stumpage of 1,500 feet per acre. The reduction of the cut by 1,500 feet per acre has increased the logging expense per 1,000 feet of stumpage removed,—an increase which can be considered only as a new investment added to the value of 1,500 feet per acre left.

For a number of years to come, the small trees are non-removable, since it cannot pay in the near future to remove a handful of inferior lumber from an acre of ground. In the meantime, the property must be watched and taxes must be paid.

The owner leaving small trees embarks in a new venture which cannot be countermanded nor altered, for years to come, without serious loss; and which is subject to more serious dangers than the old venture.

Small trees form, prior to the removal of the big trees mixed with them, a tangible, merchantable asset. After the removal of the big trees, however, they can be considered only as an intangible asset, an asset of merely prospective value, an asset impossible to realize on.

3. After lumbering, small trees left are much more endangered by fire, windfall, insects, fungi than before lumbering. Where fires cannot be controlled at a reasonable expense, conservative lumbering is, under almost any circumstances, absolutely absurd.

4. The soil on which small trees are left,—in order to grow into better dimensions and in order to act as seed trees for a third growth,—cannot be used for pasture without interference with the object at stake.

5. Conditions may arise, before a second growth of small trees becomes merchantable, rendering the soil occupied by them valuable for farming purposes. In that case the small trees must be removed without any benefits accruing to the owner from such removal.

6. The taxes on land completely stripped are lower than the taxes on land conservatively lumbered. When a long number of years is required to convert a second growth left into a merchantable stand, the taxes annually paid "*ad valorem*" and increasing at a compound ratio, form a countercharge against the slowly increasing value of the second growth difficult to countenance.

Considering these various points, the financier cannot be called unwise when he prefers investments in first growth forest to those possible in second growth.

Many a man in the United States and in Canada has made a fortune by clever investments in first growth, whilst no one, practically, has had a chance to show dividends obtained from second growth forest (exceptions: farm wood lots; second growth pine in Virginia).

Under what conditions, it may be asked, can or does conservative lumbering pay in primeval woods?

The conditions are those under which any business proves to be remunerative, . . . . be it a livery business or a hotel, a railroad or a music store: that business alone can be remunerative in which the parts composing the business investments are at hand in proper proportions; that business alone can be remunerative which is established in an economically proper site; that business alone can be remunerative, which is safe from over-taxation and—by insurance or otherwise—safe from accidental destruction of its assets.

Let us take the livery business for an illustration: The investment consists of several components, viz.: horses, carriages, harness, saddles, buildings, feed. These components must be at hand in proper proportion. It would be preposterous, for a livery, to have invested, e. g.,

| | |
|---|---|
| in horses | $ 1,000 |
| in carriages | 25,000 |
| in harness | 100 |
| in saddles | 50 |
| in buildings | 350 |
| in feed | 15,000 |

Again, the proper economic site for a livery business is in the city, the village—not in the back woods of Maine; not in the wild swamps of Minnesota; not indeed in Chicago one hundred years ago; which shows the dependence of economic sites on economic development. Finally, a livery business is never overtaxed, and all of its investments allow of being insured. There is, probably, many a livery in the United States whose owner is "falling behind,"—usually because his investments are wrongly balanced or because the site of his business is wrongly selected. Still, it would be wrong to conclude that a livery business is generally a poor business.

Properly arranged within, properly arranged without; properly insured against accidents a business *must* be remunerative.

Applying this logic to conservative lumbering as a business it is safe to state that it must be remunerative

A. Where its components are properly balanced.

B. Where an economic site is obtainable for its conduct.

ad. A: The components of a business investment in conservative forestry are partly derived from nature (natural gifts, natural powers) and partly made by man. The natural components are usually at hand in primeval forests,—which does not mean to say that they are at hand in proper amounts. The components made by man are added to those made by nature and consist, above all, in investments permanently employed for forest utilization.

Thus the aggregate investments in conservative forestry may consist of all of the following components—whilst only No. 1, No. 2 No. 8, No. 11 and No. 12 are considered essential:

(a) Natural components:
1. Soil.
2. Trees.
3. Fish and game.
4. Minerals.
5. Water power.

(b) Semi-natural components:
6. Pastures.
7. Farms and orchards.

(c) Artificial components:
8. Permanent means of transportation.
9. Logging appliances.
10. Industrial establishments.
11. Means to prevent and to subdue forest fires.
12. Surveys, maps, working plans.
13. Ranger houses, workmen's houses, lumber camps.
14. Nurseries.
15. Silvicultural improvements.
16. Capital set aside to defray taxes, protection, administration and other current expenses.

In the case of well-stocked virgin woods, the aggregate final investment is likely to be lower than the original purchase price of the forest, when the virgin forest contains a surplus of mature timber exceeding in value the expense required for the establishment of the essential artificial components.

In the American forests, after the usual lumbering operations, very little is left of the natural components; as a consequence, relatively heavy additional investments are required (as a rule without a chance of deriving immediate revenue) in order to make the aggregate, in time to come, a permanent source of revenue.

The conclusion is simple: Unless the owner, *before* he begins to operate primeval woods, decides to embark in conservative forestry, the chances are slim that he will ever embark in it.

In German working plans the necessity of ascertaining the most opportune amount of capital to be invested in forestry is invariably overlooked. The explanation lies in the following:

1. The value of the growing timber and of the soil comprises, say, 95 per cent. of the investment.

2. The means of transportation are already at hand, developed at a time at which financial considerations were not made in forestry.

The "period of installation" should cover as many years as are required to obtain the proper total and the proper composition of the forestal investment.

It is unfortunate that the period of installation in conservative forestry must comprise a number of years; whilst other investments (e. g., a livery) can be fully installed in the course of a few weeks or a few months.

ad B: Whosoever has traveled in recent years through Germany with an eye to the forest can not be in doubt that every state and every county offers innumerable sites at which conservative forestry can be conducted as a remunerative business. Indeed, economic sites are at hand in Germany wheresoever the trees do not happen to occupy farming soil.

Such was not the case in Germany two hundred years ago; and such is not the case in Russia, Canada and the United States today.

Economic sites are those where stumpage values range high; where natural reproduction is easy; where the danger of fires is small; where the land is unfit for agriculture; where forest taxes are low.

These conditions prevail, particularly, in the pineries of the Coastal Plains and in the hardwood forests of the higher Appalachian region.

It must be clearly understood that these conditions did not —or did not all—prevail some 20 years ago; further, that the absence of such conditions in the West *anno* 1907, does not render conservative forestry in the West for all times impossible.

It is unfortunate, indeed, that the majority of these conditions arises only at a very late hour, to-wit, invariably *after* the general disappearance of the primeval woods.

No man in the United States has had, so far, sufficient confidence in conservative lumbering to postpone the tapping of his primeval woods until the "economic site" for conservative lumbering had locally arisen.

The man who does will never live to regret his confidence.

## CHAPTER IV—METHODS REGULATING THE YIELD IN WOOD AND TIMBER

The question as to the amount of timber which might be removed annually without reducing the growing stock (the main investment) has occupied the minds of foresters since many centuries. European governments prescribe definite methods by which the yield of a forest is to be regulated. The family laws governing entailed property do likewise. For America, at the present moment, these methods will find application in rare cases only. A sustained yield in virgin forests containing large numbers of idling trees is an economic absurdity. Pulp mills, tanneries, and other industrial establishments requiring large investments to be made close to a forest may, however, seek for sustained yields on cut over lands, from which the idling trees have been removed.

## PARAGRAPH XVIII.

### GENERAL REMARKS.

The methods commonly used for regulating the "possibility" of the forest are:

A. Brick masonry methods.
  1. Area method (Par. XIX.)
  2. Volume method (Par. XX.)

B. Formula methods.
  3. Charles Heyer method (Par. XXI.)
  4. Hundeshagen method (Par. XXII.)

C. Increment methods.
  5. Common increment method (Par. XXIII.)
  6. Brandis method (Par. XXIV.)
  7. Pinchot method (Par. XXV.)

These seven methods consider the forest as a whole, ascertain the productive capacity of the whole, and locate the annual cuttings thereafter.

The methods to be considered in the next chapter (V.), treat every part of the forest according to its individual financial merits, thus locating the cuttings to begin with. Thereafter, they merely see to it, if necessary, that the total cuttings of a year agree with the consuming capacity of the market.

## PARAGRAPH XIX.

### AREA METHOD.

The simplest way to regulate the yield by area is a division of the entire forest area into as many lots as the rotation numbers years. This scheme has been followed often in the case of coppice forests having rotations less than forty years. In the case of high forests, the rotation is divided into a number of periods of equal length (ten to twenty-four years). On the "Statement of Ages" the acreage of each compartment is allotted to that periodical column to which it belongs according to its present age. The oldest compartments are allotted to period number one; the next oldest period number two, etc. The total acreage allotted to each periodical column is found by addition and compared with the average contents of a column. If a column contains too much acreage, the surplus is shifted backward or forward into adjoining columns. Compartments growing vigorously are shifted backward into later periods and vice versa. After shifting, each column contains *in toto*, approximately, an equal number of acres.

By valuation surveys or yield tables, the volume contents of the compartments allotted to the first period are ascertained; and the contents are increased by the probable volume increment of these compartments expected during half a period. The total contents are then divided by the number of years comprised by the period. The result is the annual "sustained yield." Obviously, the sustained yield is apt to change at the end of each period.

The installation period comprises a whole rotation. At the end of a rotation the forest is sure to exhibit a more normal age gradation.

This method is in use in Prussia, Bavaria, etc., and has been working in almost all European forests since 1780. The method is not applicable to selection forests. It might be improved by replacing the "Statement of Ages" by a "Statement of Indicating Percentages."

## PARAGRAPH XX.

### VOLUME METHOD.

A statement of ages is prepared, each compartment being allotted to a periodical column according to the number of years which separates it from maturity. The compartmental entries made in the statement of ages are, in this case, however, the final volumes expected at maturity, and not the compartmental acreages.

The totals for each period are drawn and compared with the average volume expected from each periodical column. Again, by shifting compartments onward and backward, surpluses are shifted into columns showing a deficit, under adequate allowance for changed yields. The possibility is obtained by dividing the total of the first column, as it stands after shifting, by the length of a period.

The method does not work towards normal age gradation. The shifting of volumes is times taking, and the method is not in use nowadays.

## PARAGRAPH XXI.

### CHARLES HEYER METHOD.

By cutting the actual annual increment, the growing stock is left undisturbed. In order to convert the actual growing stock into a normal growing stock, it is necessary to decrease the annual cut if the normal growing stock is larger than the actual growing stock; and to increase the cut if the normal growing stock is smaller than the actual growing stock. Heyer expresses this idea by the formula: The annual possibility (P) is equal to the sum (S) of the expected average increments diminished by the n'th part of the difference existing between the normal growing stock (Ng) and the actual growing stock (Ag).

$$P = S - \frac{Ng - AG}{n}$$

"n" is the number of years forming the installation period.

The field work in this method is timestaking; especially so under the selection system or group system when the actual growing stock can be ascertained only by complete valuation surveys. On the other hand, the method prevents any over-cutting or any under-cutting of the forest, and shows clearly how much of the revenue obtained is, in fact, net revenue and not capital withdrawn, or else, how much of the revenue is left latent being used to increase the original growing stock. This method is well adapted for irregular forests. The method requires:—

1. A detailed description of compartments giving the normal and actual volume, and the normal and actual increment for each compartment.

2. A statement showing the normal growing stock, the actual growing stock, and the total increment for the period of installation.

3. A statement enumerating the compartments in which the possibility is to be cut.

No particular stress is put on reaching a normal gradation of age classes.

## PARAGRAPH XXII.

### HUNDESHAGEN METHOD.

Hundeshagen assumes that the ratio existing between the increment and growing stock is constant. With the help of yield tables, he ascertains the ratio existing between normal increment and normal growing stock and, further, the actual growing stock found in the forest. Multiplying the actual growing stock by the above ratio, Hundeshagen obtains his actual annual possibility of the forest.

In normal forests (yield table forests), the ratio is necessarily at an optimum. If that optimum is applied to abnormal forests, over-cutting seems the necessary consequence. Absurd results are apt to crop out if the growing stock is under normal and the increment poor.

Inasmuch as the method requires periodic stock taking, over-cutting or under-cutting the forest for any length of time is, however, excluded. Indeed, any method is good which controls its own results by periodic stock-taking. Hundeshagen's method is applicable to all sorts of silvicultural conditions, and might well be applied in a tentative first working plan. In that case, it will be sufficient to express the ratio, "normal increment over normal growing stock" by the fraction $\frac{2}{n}$.

## PARAGRAPH XXIII.

### COMMON INCREMENT METHODS.

The increment methods are the oldest and roughest methods of yield regulation. The underlying idea is the following: As long as only the increment is cut—no more, no less—an overcutting of the forest is impossible. The average production per acre can be ascertained from yield tables, by systematic experiments, or, as is the usual practice, by estimating.

The methods do not pay any attention to normal growing stock, normal age gradation and normal increment. The methods are not applied anywhere, nowadays, in scientifically conducted forestry.

## PARAGRAPH XXIV.

### BRANDIS METHOD.

The Brandis method was first applied by Sir Dietrich Brandis in the Teak forest of Burma. The method ascertains the number of mature trees in a forest as well as the time which an equal number of trees styled "immature," next in diameter to the mature class, require to grow as large as the mature trees are, so as to be fit to replace them.

Dividing the number of mature trees by the period of replacement, the annual possibility of the forest is ascertained. The method perpetuates the original composition of the forest, calling it normal because natural.

An illustration might be obtained from the data contained in bulletin No. 32, Bureau of Forestry, prepared by F. E. Olmsted:

Diameter of mature trees, 20 inches and over.

Number of mature trees, per acre, 4.94.

Number of immature trees, having 15 inches to 19 inches diameter, per acre, 4.99.

Number of years required by a 15 inch tree to grow mature, 34.

The annual possibility, after Brandis, in this case amounts to

$$\frac{4.94}{34} = 0.145$$

mature trees per acre, or 145 mature trees for every 1,000 acres.

After bulletin No. 32, the volume of the trees having 20 inches and over at breast height is 4561 feet b. m.

The possibility in lumber is, consequently,

$$\frac{4561}{34} = 134$$

feet b. m. per acre per annum.

## PARAGRAPH XXV.

### PINCHOT METHOD.

The published working plans for which Mr. Gifford Pinchot is responsible as author or as forester of the U. S. Forest Service, are, notably, the following:

The Adirondack spruce, published by the Critic Co., New York;

A Forest Working Plan for Township 40, Bulletin 30; Bureau of Forestry;

A Working Plan for......................., Arkansas, Bulletin 32; Bureau of Forestry;

A Working Plan for......................., South Carolina, Bulletin 56; Bureau of Forestry;

A Working Plan for......................., Alabama, Bulletin 68; Forest Service.

These publications fail to be working plans in the proper sense of the word. This failure might be due to the educational character of the publications. Whilst they define the term "working plan" as "simply a scheme of management for a forest tract," the reader looks in vain for an actual "scheme of management." Forest utilization, which commands the lion's share of forestal activity, is not considered by the scheme of forestal management.

The Pinchot method is classed as an increment method because it lays all stress on yield forecasts. Future yields are forecasted on the basis of a first cut, reaching down to a stated diameter limit, for periods covering from ten to fifty years.

Continuity of action is not advised in any case. Forestry as an investment is considered in bulletin No. 32 and No. 68. Table No. 15 in bulletin No. 32, however, showing the interest on the assets left by lumbering in virgin woods and depending as to their size on the severity of such lumbering, is incorrect.

After the Bureau, a working plan should contain:

1. A statement of facts.
2. A statement of yield capacity.
3. A statement of market and transport conditions.
4. A systematic plan for lumbering.

Only one-half page of bulletin No. 32, comprising 48 pages, is devoted to point 3, and only two pages to point 4.

The chief rules of management are in all working plans:

1. A fixed stump diameter limit.
2. A fixed height permissible for stumps.
3. Recommendations to prevent fire.
4. Recommendations to prevent damage to young growth.

Bulletin No. 68, published in 1905, excels in clear financial considerations of the merits of a second growth, judged according to diameter limits observed in cutting.

# CHAPTER V—METHODS REGULATING THE INVESTMENTS AND THE RETURNS

The methods to be described in the three paragraphs following are:
Judeich Method (Par. XXVI.)
Raess Method (Par. XXVII.)
Schenck Method (Par. XXVIII.)

Judeich, Raess and Schenck advocate conservativism only when conservative forestry pays better than destructive forestry.

A "sustained yield" is considered only where it guarantees better financial results than an irregular yield.

No two forests are alike. The financial development of any forest offers a problem of its own; on the basis of a difference existing in the resources of the forest; the accessibility of the forest; the availability of manual labor; the climate; the dangers threatening the forest, etc.

Aside of these tangible differences there is invariably met another intangible difference in two forest problems otherwise comparable,—due to a difference in ownership. Among the problems confronting the managing forester, the most difficult is, perhaps, the task of ascertaining the definite desire of the owner. This task is more trying in the case of individual ownership than in the case of stock companies.

Working plans cannot be made for a forest when an owner, lacking continuity of purpose, is subject to whimsical fluctuations of mind; or when the owner's financial status happens to be of a shaky nature.

It must be clearly understood, on the other hand, that a "working plan" is a plan merely outlining a definite policy; a policy to be followed as long as (and no longer than) the economic conditions surrounding the financial problem remain unaltered.

The market of forest products in America is—unlike the German market—an interstate market, not a home market.

In Germany the sustained yield of the forests is framed, essentially, with a view to the consuming capacity of a home market.

In this country, so far, no attempt is being made towards the adjustment of a supply of lumber and demand for lumber—with the exception only of the cypress industry which, controlled by firms of remarkable strength, seems effectually to establish an equilibrium between lumber demand and lumber supply.

In the production of the hardwoods and of pine, concerted action of the producers toward a similar end is, for the time being, a pious wish.

"Concerted action" of the producers is usually decried as a "trust." From the patriotic standpoint, no more beneficial trust can be imagined than a lumber trust.

The German sustained yield, adopted by practically all owners of stumpage, amounts to a "trust-yield."

There is no possibility—neither abroad nor here—to establish an absolute equilibrium between production of trees and consumption of lumber, the latter being subject to continuous fluctuations, whilst the former allows only of slow alterations.

The American producers, with rare exceptions, have never attempted to curtail the output of the lumber industry. On the contrary, when the price of lumber was low, when the margin of profit was small, the producers have usually increased the production so as to obtain the surplus receipts required to meet pressing financial obligations (mortgages, bonds, notes due, etc.)

The output of the lumber industry has risen by leaps and bounds; and it is astounding that the prices of lumber have advanced, nevertheless, by bounds and leaps.

The advance of lumber prices is certain to continue, the available supply of merchantable timber declining from month to month.

An increased production of stumpage we may expect, indeed, to take a start when the price of stumpage has increased at a ratio proportioned to the increased price of lumber.

Still, many a year must elapse before an increased production of trees can result in increased offerings of lumber. In the meanwhile, the famous "law of demand and supply" is set at rest; and prices will continue to climb upward.

## PARAGRAPH XXVII.

### JUDEICH METHOD.

Judeich's method treats every part of the forest according to its own financial merits. The management of the forest as a whole is merely a consequence of the requirements of the individual woods composing it. Sustained yield of volume or money does not underlie Judeich's method. Where the capacity of the market requires it, however, sustained yield is advised.

The treatment for each piece of wood is prescribed in detail for the next working period. From these prescriptions the total volume yield of the period as well as the total area to be cut during the period is finally ascertained.

The normal growing stock is entirely disregarded. Working plan periods shall not exceed ten years; and every five years a thorough revision of the entire working plan shall take place.

Judeich puts great stress on the development of proper cutting series (small). The lumberman's axe is meant to enjoy freedom of action and a multitude of points of attack.

For each working section the financial rotation is determined. Judeich realizes, however, that the financial rotation is subject to change and is satisfied with fixing it approximately. The plan of cutting embodies the following points:

There must be cut:

1. All economic necessities, especially severance cuttings.
2. All decidedly mature woods the indicating percentage of which is too low.
3. All woods which must be sacrificed to the proper progress of the axe within the cutting series; for instance, a group of polewoods lying between two mature pieces. Whether such a sacrifice should be made or not is answered according to the rules of forest finance.
4. All such woods as are about to mature, as far as such woods can be reached by the axe in the proper progress of cuttings. These are the pieces for which an exact examination of the indicating percentage is particularly desirable; which, however, are so near financial maturity that mistakes made will entail small losses only.

By summing up the areas and yields of the above headings, the periodical yield is ascertained. Control is required whether or not the market is able to consume that yield without changing the prices of forest produce on which financial calculations are based. The contents of the working plan are as follows:

1. Actual conditions of the forest.
2. Compartments, cutting series, plan of road building.
3. Yield.
4. Future treatment, silviculturally, and forest utilization.
5. Detailed descriptions of compartments and sub-compartments.

## PARAGRAPH XXVII.

### RAESS METHOD.

The method recommended by Dr. Raess might be termed the method of sustained money yield. The method pays full attention to the silvicultural as well as the financial requirements of the forest, and gives the forester great freedom of action. Raess realizes the financial mistakes due to a strictly sustained timber yield, and finds, on the other hand, that a sustained money yield is a necessity for the proper balance of annual budgets in case of wood-owning families, communities, or states.

Like Judeich, he treats every piece of the forest according to its financial merits. If the revenue thus obtained exceeds the normal revenue, when the excess is placed in a bank and left over for lean years, etc. The normal revenue is that which brings the normal indicating percentage on the capital value of the forest. Normal growing stock and age gradation are discarded. Periodic stock-taking, not of timber but of values, forms part of the working plan. Over-cutting as well as under-cutting is thus prevented. The enormous amount of bookkeeping required has prevented the introduction of this method in the German practice.

## PARAGRAPH XXVIII.

### SCHENCK METHOD.

Schenck foots on the belief that forestry is business; and, enlarging upon this truism, that forestry is at its best when it pays best.

Schenck's working plans do not advocate conservative forestry; they advocate destructive forestry whenever the destruction of the trees promises the best financial results; they advocate conservatism—to a lesser or higher degree—where conservative management seems to be the most productive of dividends; they advocate a policy of patient waiting whenever it recommends itself financially.

Schenck's working plans are, consequently, according to the exigencies of the situation and of the owner:

either merely plans of silvicultural development;
or merely plans of forest protection;
or merely plans of utilization;
or plans combining silvicultural advice with a distinct plan of lumbering and forest protection.

Schenck's working plans are characterized by the following:

1. After revising in detail the investments existing in the forest, Schenck shows the most opportune level to which the various components of the investment shall be either raised or lowered. Bad investments must be eliminated. Good investments must be added.

2. Schenck considers, as sources of forestal revenue, not merely the trees but as well the farms, the meadows, the pastures, the minerals and the water powers available on the forest property.

3. Schenck forecasts the cash revenue obtainable from the adjusted investments,—not merely the yield in lumber and wood; he confronts the forecasted revenue with the revenue obtainable from unadjusted investments.

4. In plans of conservative forestry Schenck insists on the necessity of permanent protection from fires and of permanent investments to provide facilities of transportation.

5. Schenck insists that in forestry as in railroading, banking, insurance, etc., calculation at compound interest must be applied to the comparison of receipts and expenses.

6. Periodic stock taking is demanded, so as to control, from time to time, the actual status of the entire investment.

7. Trees are either good or bad investments, and should be treated

—as individuals or as aggregates—according to their financial merits. The trees are divided into four classes:

(a) Money makers, promising to increase in stumpage value at a rate of interest higher than normal; *trees to be preserved.*

(b) Indifferent trees, yielding a normal rate of interest, merely, through growth in volume, value and price; *trees to be preserved or cut.*

(c) Idlers, merchantable trees yielding an inadequate rate of interest; *trees to be cut.*

(d) Weeds, trees of negative value (not merchantable), never promising any revenue; *trees usually left to rot.*

Practical experience in the woods, in the mill and in the office is required to allot a given tree correctly to one of the four classes given. Volume tables are of little use in the determination of the maturity of a tree.

8. A sustained yield is recommended only when it promises greater safety or higher remunerativeness of the investments.

Schenck's working plan reports consist of the three parts given in Chapter III, viz.:

first part, detailed statement of facts;
second part, statement of the owner's desire;
third part, detailed plan of action.

The plan of action weighs the financial merits of all methods of development or treatment possible under the prevailing conditions and shows the financial superiority of its own recommendations over any other proposed plan of management.

The heads under which the first part and the third part are treated should be those given in paragraph XVI.

The "installation period" is the time required for the proper adjustment of all investments.

The annual working plan is an annual budget. It dwells in detail on that part of all provisions of the chief working plan which should be carried out in a given year of the period of installation.

# FORESTRY FOR KENTUCKY

## A Stereopticon-Lecture Delivered at the Invitation of the Louisville Board of Trade by C. A. Schenck, Ph.D. Forester to the Biltmore Estate.

Spring has come, and every tree freshly attired in a brand new spring gown is, to the educated, and often times to the uneducated as well, an object of joy, welcomed like a friend returning from abroad after a winter's absence. In fact, we all love trees, like friends, as friends. And true it is; the trees are our friends! They yield the shade about our homes; they improve the air we breathe; they filter the water we drink; and,—to speak of a more concrete service,—they furnish the chairs, on which my audience sit.

**Man and Tree**

As friends, the trees show more unselfish kindness than human beings.—For it must be confessed: we do not reward their friendship by anything beyond platonic love: we do not actively work for their benefit, we fail to repay *their* deeds by *our* deeds. We behave like the child, who, walking alongside his mother, with a nickel in hand, meets a blind beggar assiduously grinding his hand-organ. In spite of the mother's admonition, the child refuses to part with his nickel, crying: "Papa gave me the money to buy candy,—and the blind man will play the organ anyhow!"

Sure enough: The trees, too, will work for us anyhow, without any complaint, without any remonstrance. The only sound which we hear from the tree, is the song of the bird nesting in its branches, or the lisping talk of the leaves exchanging their daily observations fanned by the evening wind, or, sometimes, the low-tuned assurances of subservience, when the tree humbly bows before his majesty the storm. And then, finally, that last heartrending cry of deadly anguish strikes our ear, when the tree falls a victim to the murderous axe.

**Forestry as Forest Utilization**

Evidently, ladies and gentlemen, you see before you a German sentimentalist. Of course, all Germans (—my pronunciation easily betrays me—) have a strong sentimental vein more or less covered by a skin of good humor. Still, I am free to maintain, that the phrase "Woodman spare that tree" unceasingly ruminated by some eastern sentimental cranks, has done more harm to our trees and to the advancement of American forestry than all recklessness of the lumberjack in the backwoods. I, personally, annually put to death hundreds of thousands of trees; not alone the shrubby specimen fit for firewood only. No, thousands of gigantic oaks and tulip trees up to six feet in diameter—trees born before Columbus landed, trees the equal of which I can never reproduce!

PICTURES OF APPALACHIAN FORESTS

More than that: I skin,—a real forestry-vandal—the bark of the venerable old chestnut oak, and allow the naked body of the tree to go to waste in the woods. If I tell you in addition, that hundreds of flowering dogwoods have been extirpated by me, you will certainly indict me for "cruelty to trees," and I shall never leave this noble city alive.

Allow me, however, a word of justification before proceeding against me!

It is my belief, that this glorious commonwealth cannot have forestry on a large scale (—that is the only kind I am interested in—) unless forestry is a remunerative business. Agriculture and mining have shown a marvelous development, because they were found to be well paying industries. Forestry must follow suit, must cease to be a luxury, if we want it to grow strong. And there is many an acre of ground in Kentucky, devoid of minerals, unfit for the plow, but productive of trees, which I want to claim for forestry as a business. Such land will lie idle, unless it is used for tree growth,—and idlers should be suffered in political economy no more than in our family-life.

Some help will be required to start proper forestry,—just as it was and is the case in other industries, and to offer such help, we should at once engage in concerted organized action. By proper laws, by educating the people, by interesting the newspapers, by forming a Kentucky forestry association—we must level the road to forestry as a business.

**Capital in Forestry** Now you will ask me: "How can we establish forestry as a business?" You have plenty of good business men in Louisville, and they will tell you, that any business requires a certain amount of capital, in most cases the more of it the better. You cannot run a livery stable on one horse, or a dairy on one cow, nor can you imagine a successful railroad to be only two or three miles long.

Similarly, commercial forestry requires large holdings, —the larger the better. In such large holdings every foot of ground must be used for that production. under which it pays best: bottomland for agriculture; bare ridges for pasture; cold northern slopes for tree growth. The famous Black-forest in southern Germany is far from being a wilderness. It was an impenetrable wilderness three hundred years ago. Now it is dotted with farms and villages traversed by a splendid system of stone roads.

BLACK-FOREST PICTURES

Similarly, at Biltmore, N. C., on George Vanderbilt's estate, I try hard to use every resource of the soil to best advantage. The old and mature trees are removed and made into money, making room for an offspring of healthy second growth.

PICTURES BILTMORE CUTTINGS

**Forest Planting** Only in exceptional cases artificial planting of trees is resorted to. Nature has regenerated the forest periodically ever since the creation, and nature is not apt to stop work in the twentieth century. Thus I allow nature to re-forest the lumbered land, increasing only the chances for that set of conditions, which gives rise to a tree.

BAVARIAN PICTURES.

Still, near Asheville, N. C., where the stumpage price of wood is over a dollar per cord, and where many an abandoned field or a previously devastated wood lot has been put in my charge, I am annually engaged in artificial reforestation.

Such reforestation is costly. Still, is it not more costly to allow land to lie barren, which was acquired at—say—$15 per acre, and which requires annually an expense of 10 cts. to defray the taxes? Is it not wisdom to invest another $10 or $20 for reforestation, if such additional investment allows of a prospect to make three or four per cent. interest on the entire capital? And these returns are safe. As soon as a plantation is established, nothing can prevent it from growing. The annual growth represents annual returns stored away by the forest. The components of growth are air, rain and sunshine, and the forest grows and accumulates compound interest on its capital value as sure as the wind blows, the rain falls and the sun shines.

The history of many a wood owning family abroad proves unmistakably, that no investment yields returns so incessantly as forestry, and there is a good old German proverb: "The forest is the father's saving-box!" Empires are wrecked, and the imperial bonds lose their value; railroads, banks, factories go to the wall, and the shareholder loses his money; but the well managed forest grows, and cannot help growing in size and value.

**Virgin Forests**

I must put stress on the words, "the well-managed forest." For the primeval forest is unproductive, unless stumpage prices advance sharply, the annual formation of timber being exactly offset by the annual decay of timber. The forester does not intend to preserve the virgin woods. He removes as quickly as possible all such trees, which have reached their prime, which are mature, which have ceased to yield, by their annual growth, sufficient interest on their own value. Thus the timber originally contained in a forest is cut down to that figure, at which the highest returns on the remaining investment are obtained.

That remaining investment consists of young and healthy seedlings, saplings, poles and trees, and I am somewhat doubtful, whether even from the aesthetic standpoint such strong and vigorous second growth is not superior in beauty, as well as in returns, to the original growth from which it has emanated.

In forestry, the original investment is, on the other hand, increased by outlays made for railroads, roads, shutes, flumes, farm-buildings, irrigation ditches, pasture fences, telephone lines, etc., etc. In Western North Carolina it is especially the systematic development of graded dirt roads, that the business forester has at heart.

**Forest Roads** In fact, the forestry advocate must invariably be a friend of good roads. The tree in the back woods, in spite of its size, has little value, because it is beyond the reach of transportation. If the old tree has little value, the small sapling tree has none at all, and it is poor business to spend a penny for its preservation or propagation. Only by improved means of transportation I can increase the value of my trees, poles, saplings and seedlings, and if I succeed, by spending $10,000 for roads, in raising the value of the forests by $20,000, then those $10,000 are certainly well invested.

These roads, at the same time, make our woods accessible to the health-seeker, the sportsman and the tree lover. You have plenty of forests in Kentucky, one-half of the state still being tree-clad. But all the recreation obtainable from the woods is wasted on you, as there are no roads bringing the forests within your reach. How many of you see the woods from a point of observation other than a car window? Do you realize from personal experience what pleasure a close contact with nature has in store for you?

**State Forestry** Of course, the man of small means and the owner of a small piece of forest cannot do much in the line of permanent improvements. And that is one of the reasons why, in my opinion (not shared by some lights in American forestry) the small man is incapable of practicing proper forestry. Only the wealthy, public and private corporations and pre-eminently the state and federal government are fit to embark in that forestry which we all desire to obtain.

The returns from a forest are partly tangible and measureable: f. i. timber; tanbark; turpentine; and partly immaterial and latent: f. i. the influence, which the forest exerts on public health, sport, navigation, floods, springs, and so on.

The private owner of forest lands does not care to produce these immaterial blessings, as there is no money in their production; thus he is apt to neglect them entirely. The people as the owner of woodlands, on the other hand, may combine the material and immaterial production of the forest, with a view of deriving the greatest direct and indirect advantage from their forestry possessions.

As we want forestry for the people, we had perhaps better practice it through the people. The state of Kentucky can, I judge, easily acquire a tract of say 200,000 acres as a starter and a nucleus for a state forest-reserve. If necessary—probably it will be necessary in order to make the reserve a compact body—the state might use her right of eminent domain and condemn such tracts, as are most desirable for a reserve. The expense to be incurred for purchases, surveys, lawyers' fees, roads, buildings and salaries should be defrayed from a public loan. The bonds forming the loan, backed as they will be by realty-assets, can certainly be issued at a low rate of interest. I dare to predict, that the reserve properly selected and placed under proper management, will be able to pay the interest from the beginning out of its own gross returns. The staff of forestry officers must be entirely non-political, so as to avoid changes of personnel, which are no where more disastrous than in a forest administration. Hence some connection of the service with non-political bodies, f. i. the State University, the Board of Trade, the Women's Clubs, the Forestry Association (if there is any to be) seems extremely advisable.

In order to do justice to the counties, over which the reserve extends, and in order to avoid county antagonism against a step taken on behalf of the whole people, it will be necessary for the state as a forest owner not to shun the payment of the usual county taxes.

**Forestry Education** Kentucky can already boast of a unique institution devoted to forestry: it is the forestry-school at Berea, in charge of my friend Prof. S. C. Mason. At Cornell and Yale, scientific forestry is taught by experts of national fame, and at my own forest-school, at Biltmore, N. C., I try to raise forestry superintendents by the dozen. Thus we are sure to be well supplied with highly educated foresters. But, unless they are trained at Berea, I do not know of a single place in America, where the subaltern staff of forestry,—the ranger and the fire warden,—may receive its technical and scientific preparation. In addition, Berea does a world of good by impressing the mountain-boy with the fact, that the young tree,—like the horse colt,—has a value, although it is still unfit for use; that it is wise to husband and protect a young tree, because the young tree is apt to be serviceable at the time, at which the boy has developed into a man.

**Possibilities** Economically, the forestry problem is of great importance to your state. About 25,000,000 acres of Kentucky soil are still classed as woodlands. Under proper forestry, every acre of woodland produces annually 200 feet b. m., worth about 40 cts. Thus your 25,000,000 acres could produce $10,000,000 per annum, a raw production which offers the wage earner a chance of obtaining $20,000,000 when the raw product is converted into fine product. It looks as if it was advisable to spend a few thousand dollars annually for the benefit of the forest when such prospects are at stake. And those prospects are not of a chimerical nature! They cannot fail to realize, if a second growth is allowed to spring up in our woods. The main obstacle to a second growth are forest fires preying on the young trees, which easily succumb to a conflagration, whilst the old timber is fairly well protected against damage by a fire proof armor of heavy bark enveloping the trunk.

**Forest Fires** Some thirty years ago, forest fires were a necessity; the tree like the rock, was an obstacle to the plow, and its shade prevented the development of field crops. The tree was a weed that had to be extirpated. The momentum of tradition is so strong amongst our farming people living close to or in the midst of woodlands, that both school and legislature will have a hard task when trying to end the antiquated practice of firing the woods. Still, this firing of woods *must* be stopped, if forestal investments shall have that degree of safety, which invites capital to embark in an industrial enterprise.

## PICTURES FOREST FIRES IN THE SOUTH AND NORTH

At Biltmore, unaided by legislative help, I am fighting the mountaineer bitterly, who destroys or threatens to destroy my growing wood crops. Gradually the development of my road system gives me an advantage. I make friends by giving employment; in case of a fire, a force of men is quickly hurried to the place of conflagration. A fire, unless fanned by a hurricane, scarcely jumps across a road, and if there be a strong wind, the road serves as a basis for back firing.

I sincerely hope that those of you, who engage in forestry in this state, will find the legislature at Frankfort more favorably inclined towards forestry and forestal investments than the legislative body ruling the Tar Heel State.

Whether or not an industry flourishes, depends on economic and civic conditions. The economic conditions are certainly favorable to forestry; the prices of timber advance constantly, and the means of transportation are increased and cheapened from year to year. But unless forestry is offered that protection, to which it is entitled as a tax-payer, —a tax-payer, who is incidentally a benefactor to its country—it cannot possibly find a foothold in Kentucky.

**Conclusion** There are two directions, in which forestry may develop: The one is "state forest reserves;" the other "private forestry" made possible by adequate legislation.

I strongly advise you to take steps in both directions.

# OUR YELLOW POPLAR.

## NOTES AND TABLES

### Showing Contents and Value of Poplar Logs and Poplar Trees

collected and arranged by

**C. A. SCHENCK, Ph. D.,**

Forest Assessor to the Government of Hesse-Darmstadt,

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# PRELIMINARY REMARKS.

The wood owner and the forester unite in the endeavor of drawing the largest possible returns from the forests, with which they have to deal. The average wood owner, however, wishes to derive the highest possible cash receipts in the nearest possible future, striving to convert every portion of the property, soil and trees, minerals and waters, into money to be engaged in other speculations.

The forester, on the contrary, allows any and all parts of the investment to remain invested, which are paying sufficient interest on their value, with a view of continued ownership over them for an indefinite time.

On the other hand, the forester will take all such portions out of the investment as do not return, or cease to return good profits. He brings the capital invested down to the level—by diminishing it—or up to the level—by increasing it—at which it will return to him the highest possible interest.

For instance, the forester will sell the bottom lands, which yield higher returns under an agricultural crop than under a tree crop. Such lands, which show a fine cover of grass and a poor crop of trees, the forester will set aside for use as sheep or cattle pasture—pasture of course not after the fashion of the western herder, but in a systematic way, with a knowledge of the possible damage to the surrounding timber lands and a knowledge of the means to avert it.

The most frequent question, however, to be solved by the forester, is: Will this or that tree, by its annual growth, bear sufficient interest on the price at which it can be disposed of, considering its size and quality?

In Europe, where the number of timber species is small and where the forest contains sections stocked with trees of substantially the same age, these questions are easily solved. Owing to the equal age and size of trees over whole compartments, there is no need of concerning oneself with single trees.

Besides, the rate of growth of all species has been carefully investigated by the several governments.

In the United States the forester must find out the truth himself, at so high an expense, that the private individual generally detests forest investigations.

When I came over to this country and was put in charge of about 100,000 acres of forest, I was much embarrassed on account of my absolute ignorance as to the value of the land of stumpage, of trees, of tree-growth, the rate of taxation, the value and output of logs, the cost and risks of lumbering, milling, selling etc., etc. With the kind assistance of my young friends Griffith, Price, Olmsted, Loup and Schleussner, who were studying forestry at Biltmore during the last three years, I have now gathered some data concerning the main financial questions which meet a forester in Western North Carolina.

Mr. G. W. Vanderbilt's liberality and interest in forestry have enabled me to extend my investigations in relation to the following species:

| | |
|---|---|
| Poplar, Tulip tree, | (Liriodendron tulipifera L.) |
| Chestnut, | (Castanea Americana Sarg.) |
| Red oak, | (Quercus alba L.) |
| White oak, | (Quercus rubra L.) |
| Hemlock, | (Tsuga Canadensis Carr.) |

Of course, I do not claim that the data given in the following pages relative to YELLOW POPLAR hold good for any other conditions than those prevalent in Western North Carolina, nor is it possible for private individuals to make any such investigations on a scale sufficient to guarantee their absolute correctness.

However, my tables and remarks will throw some light upon the financial questions involved in forestry, and—this is my main hope and wish and expectation—will show the wood owner engaged in lumbering that the difference between aesthetic and financial forestry is about as great, as the difference between the principles applied on the flower bed in a gentleman's garden and those followed on the vegetable bed of a truck farm.

# NOTES TO TABLE 1, TABLE 2, TABLE 3.

It is well known among millmen that neither Doyle's Log Rule, nor the Lumbermen's Favorite Rule, nor Scribner's Log Rule, are sufficiently exact to serve as a basis for calculation relative to the output of lumber from logs.

During the past few years I sawed up nearly 1000 sample logs of yellow poplar cut in Pisgah Forest, Western North Carolina, noting carefully the actual output secured from each single log.

The following tables, 1, 2 and 3, show the contents for 12-foot logs, 14-foot logs and 16-foot logs respectively, thus ascertained, and give at the same time, to facilitate comparison, in a second and third column the figures as computed by Doyle's Rule and the Favorite Rule. I did not think it worth while to add Scribner's Rule, which I understand is practically out of use.

No one will buy ore without having a fair knowledge of its actual composition; nor did I wish to have to buy logs without knowing what they really contained.

The mill of the Biltmore Lumber Co., at which the tests were made, uses a large band saw, cutting a $\frac{1}{8}$ inch kerf. The output consists almost entirely of one-inch boards.

From the following tables, it appears, that the band saw obtains from logs less than 25 inches through more inch stuff, and from logs over 28 inches through less inch stuff than might be expected to be the case according to Doyle's Rule.

Lumberman's Favorite Log Rule is on the safe side in all cases.

The reader will find that the actual output from 12-foot logs is not exactly by one-seventh smaller, and that the actual output from 16-foot logs is not exactly by one-seventh larger than the one obtained from 14-foot logs. The deviation, however, is minute and readily explained by any one who is familiar with poplar logs.

# TABLE 1.

MERCHANTABLE LUMBER IN POPLAR LOGS OF 12 FOOT LENGTH, IN FEET BOARD MEASURE.

| Diameter, inches. | Actual | According to Doyle's Rule. | According to Favorite Rule. |
|---|---|---|---|
| 12 | 78 | 48 | 49 |
| 13 | 96 | 61 | 62 |
| 14 | 112 | 75 | 74 |
| 15 | 129 | 91 | 90 |
| 16 | 146 | 108 | 107 |
| 17 | 162 | 127 | 125 |
| 18 | 180 | 147 | 148 |
| 19 | 197 | 169 | 170 |
| 20 | 212 | 192 | 186 |
| 21 | 230 | 217 | 214 |
| 22 | 248 | 243 | 243 |
| 23 | 266 | 271 | 268 |
| 24 | 298 | 300 | 294 |
| 25 | 331 | 331 | 326 |
| 26 | 362 | 363 | 358 |
| 27 | 394 | 397 | 390 |
| 28 | 422 | 432 | 422 |
| 29 | 456 | 469 | 448 |
| 30 | 488 | 507 | 474 |
| 31 | 518 | 547 | 509 |
| 32 | 556 | 588 | 544 |
| 33 | 596 | 631 | 589 |
| 34 | 634 | 675 | 634 |
| 35 | 670 | 721 | 662 |
| 36 | 710 | 768 | 690 |
| 37 | 755 | 817 | 734 |
| 38 | 806 | 867 | 778 |
| 39 | 850 | 910 | 824 |
| 40 | 901 | 972 | 870 |
| 41 | 950 | 1027 | 910 |
| 42 | 1000 | 1083 | 950 |
| 43 | 1052 | 1141 | 1001 |

# TABLE 2.

## Merchantable Lumber in Poplar Logs of 14 foot Length, in Feet Board Measure.

| Diameter, inches. | Actual. | According to Doyle's Rule. | According to Favorite Rule. |
|---|---|---|---|
| 12 | 86 | 56 | 57 |
| 13 | 105 | 71 | 72 |
| 14 | 126 | 88 | 86 |
| 15 | 147 | 106 | 105 |
| 16 | 169 | 126 | 124 |
| 17 | 189 | 148 | 145 |
| 18 | 209 | 171 | 172 |
| 19 | 229 | 197 | 198 |
| 20 | 251 | 224 | 218 |
| 21 | 272 | 253 | 247 |
| 22 | 297 | 283 | 283 |
| 23 | 330 | 313 | 312 |
| 24 | 362 | 350 | 343 |
| 25 | 396 | 386 | 380 |
| 26 | 429 | 423 | 417 |
| 27 | 464 | 463 | 455 |
| 28 | 500 | 504 | 492 |
| 29 | 542 | 547 | 522 |
| 30 | 585 | 591 | 553 |
| 31 | 626 | 638 | 593 |
| 32 | 667 | 686 | 634 |
| 33 | 714 | 736 | 687 |
| 34 | 760 | 787 | 739 |
| 35 | 814 | 841 | 772 |
| 36 | 865 | 896 | 805 |
| 37 | 922 | 953 | 856 |
| 38 | 977 | 1011 | 907 |
| 39 | 1033 | 1070 | 961 |
| 40 | 1078 | 1134 | 1015 |
| 41 | 1130 | 1198 | 1061 |

# TABLE 3.

Merchantable Lumber in Poplar Logs of 16 foot Length, in Feet Board Measure.

| Diameter, inches. | Actual. | According to Doyle's Rule. | According to Favorite Rule. |
|---|---|---|---|
| 12 | 93 | 64 | 64 |
| 13 | 116 | 81 | 82 |
| 14 | 138 | 100 | 98 |
| 15 | 166 | 121 | 120 |
| 16 | 188 | 144 | 142 |
| 17 | 212 | 169 | 166 |
| 18 | 238 | 196 | 197 |
| 19 | 262 | 225 | 226 |
| 20 | 282 | 256 | 248 |
| 21 | 311 | 289 | 285 |
| 22 | 341 | 324 | 324 |
| 23 | 382 | 359 | 357 |
| 24 | 411 | 400 | 392 |
| 25 | 460 | 441 | 434 |
| 26 | 500 | 484 | 476 |
| 27 | 539 | 530 | 520 |
| 28 | 576 | 576 | 562 |
| 29 | 626 | 625 | 596 |
| 30 | 676 | 676 | 632 |
| 31 | 726 | 729 | 678 |
| 32 | 780 | 784 | 725 |
| 33 | 830 | 841 | 785 |
| 34 | 880 | 900 | 845 |
| 35 | 952 | 961 | 882 |
| 36 | 1020 | 1024 | 920 |
| 37 | 1090 | 1089 | 978 |

# NOTES TO TABLE 4, TABLE 5, TABLE 6, TABLE 7.

917 logs were graded and scaled carefully when entering the mill at the loghoist. Then the output of lumber grades sawed out of each single log was carefully and separately noted.

Of course we cannot look inside the logs when grading them, and two logs of apparently even quality may not furnish the same quantity of lumber of the different grades.

However, what we want to find out is the average output from logs of equal diameter and grade, as all our calculations must be based on averages.

The output in my case consisted mainly of inch stuff. The inspection was rigid and constantly controlled by the foreman.

It is a well known fact, that inspection and reinspection never tally. The difference of the two, depending on the drying process and the method of piling, is so uncertain in its effect on the output that it has been entirely neglected in the following tables. Those who make use of them must allow for that difference according to the circumstances, and following their own judgment.

The logs were arranged in four grades, viz:

A. Logs free from any defect.

B. Logs with one or two defects well located.

C. Logs with three to five defects well located.

D. Cull logs.

Accordingly I constructed the following 4 tables, denoted 4, 5, 6 and 7, finding out with the aid of graphical interpolation, what per cent. of 1s and 2s, of common, cull, etc., a log of a given grade and diameter contains.

The percentage of 1s and 2s increases and the percentage of cull lumber decreases with increasing diameter of logs.

The percentage of common decreases on the whole with increasing diameter, except in the case of cull logs.

# TABLE 4.

## PERCENTAGE

OF LUMBER GRADES SAWED OUT OF LOGS FREE FROM ANY DEFECT.

| Diam. Inches. | 1's and 2's. | Common. | Mill cull. | Dimensions. | Bright saps. | Stain'd saps. | Clear Strips. | Ship'ng cull. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 11 | .... | ........ | 40 | ........ | ........ | ........ | ........ | 60 | 100 |
| 12 | ........ | .... | 28 | ........ | 2 | ........ | ........ | 70 | 100 |
| 13 | ........ | 2 | 25 | ........ | 3 | ........ | ........ | 70 | 100 |
| 14 | ........ | 5 | 21 | 8 | 3 | 2 | ........ | 61 | 100 |
| 15 | 2 | 11 | 20 | 7 | 4 | 2 | ........ | 54 | 100 |
| 16 | 6 | 14 | 18 | 3 | 5 | 5 | 1 | 48 | 100 |
| 17 | 10 | 18 | 16 | 1 | 5 | 5 | 1 | 44 | 100 |
| 18 | 13 | 20 | 15 | 1 | 5 | 5 | 1 | 40 | 100 |
| 19 | 16 | 21 | 14 | 1 | 5 | 5 | 2 | 36 | 100 |
| 20 | 20 | 22 | 13 | 1 | 5 | 5 | 2 | 32 | 100 |
| 21 | 24 | 21 | 12 | 1 | 5 | 5 | 2 | 30 | 100 |
| 22 | 27 | 20 | 11 | 1 | 5 | 5 | 3 | 28 | 100 |
| 23 | 31 | 19 | 10 | 1 | 5 | 5 | 3 | 26 | 100 |
| 24 | 35 | 17 | 10 | 1 | 5 | 5 | 3 | 24 | 100 |
| 25 | 38 | 16 | 10 | 1 | 5 | 5 | 3 | 22 | 100 |
| 26 | 41 | 15 | 10 | 1 | 5 | 5 | 3 | 20 | 100 |
| 27 | 44 | 14 | 9 | 2 | 4 | 5 | 3 | 19 | 100 |
| 28 | 47 | 13 | 9 | 2 | 3 | 5 | 3 | 18 | 100 |
| 29 | 49 | 12 | 9 | 2 | 3 | 5 | 3 | 17 | 100 |
| 30 | 52 | 11 | 9 | 3 | 2 | 5 | 3 | 15 | 100 |
| 31 | 55 | 10 | 8 | 3 | 2 | 5 | 3 | 14 | 100 |
| 32 | 57 | 10 | 8 | 2 | 2 | 5 | 3 | 13 | 100 |
| 33 | 59 | 10 | 8 | 2 | 2 | 5 | 2 | 12 | 100 |
| 34 | 62 | 9 | 8 | 1 | 2 | 4 | 2 | 12 | 100 |
| 35 | 64 | 9 | 8 | ........ | 2 | 4 | 2 | 11 | 100 |
| 36 | 65 | 9 | 8 | ........ | 2 | 4 | 2 | 10 | 100 |
| 37 | 66 | 9 | 8 | ....... | 1 | 4 | 2 | 10 | 100 |
| 38 | 68 | 9 | 7 | ........ | 1 | 4 | 2 | 9 | 100 |
| 39 | 69 | 8 | 7 | .... | 1 | 4 | 2 | 9 | 100 |
| 40 | 71 | 8 | 6 | ........ | 1 | 4 | 2 | 8 | 100 |
| 41 | 72 | 8 | 6 | ... .... | ........ | 5 | 2 | 7 | 100 |
| 42 | 73 | 7 | 6 | ........ | ........ | 5 | 2 | 7 | 100 |
| 43 | 74 | 7 | 6 | .... .. | .... ... | 5 | 2 | 6 | 100 |
| 44 | 76 | 7 | 5 | ........ | ........ | 5 | 2 | 5 | 100 |

# TABLE 5.

## PERCENTAGE

OF LUMBER GRADES SAWED OUT OF LOGS WITH ONE OR TWO DEFECTS.

| Diam. Inches. | 1's and 2's. | Common. | Mill cull. | Dimensions. | Bright saps. | Stain'd saps | Clear strips. | Ship'ng cull. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 11 | ........ | ........ | ........ | . .... | ........ | .... ... | ........ | ........ | ........ |
| 12 | .... | ........ | ........ | ........ | ........ | .... | ........ | ........ | . ...... |
| 13 | .... | ........ | ........ | ........ | ... | ........ | ........ | ........ | ........ |
| 14 | ........ | ........ | ........ | ........ | ........ | ... | ........ | ........ | ........ |
| 15 | 2 | 14 | 25 | ........ | ........ | 1 | ........ | 58 | 100 |
| 16 | 3 | 15 | 22 | 2 | ........ | 3 | ........ | 55 | 100 |
| 17 | 5 | 17 | 18 | 2 | ........ | 3 | 1 | 54 | 100 |
| 18 | 6 | 18 | 16 | 2 | .... | 3 | 1 | 52 | 100 |
| 19 | 8 | 19 | 15 | 2 | ........ | 3 | 1 | 50 | 100 |
| 20 | 9 | 20 | 14 | 5 | ........ | 3 | 1 | 48 | 100 |
| 21 | 10 | 21 | 14 | 4 | 1 | 3 | 1 | 46 | 100 |
| 22 | 12 | 21 | 13 | 5 | 1 | 3 | 1 | 44 | 100 |
| 23 | 14 | 22 | 12 | 5 | 1 | 3 | 1 | 42 | 100 |
| 24 | 16 | 22 | 11 | 6 | 1 | 3 | 1 | 40 | 100 |
| 25 | 18 | 24 | 10 | 6 | 1 | 3 | 1 | 37 | 100 |
| 26 | 19 | 24 | 10 | 6 | 2 | 3 | 1 | 35 | 100 |
| 27 | 21 | 24 | 10 | 6 | 2 | 3 | 1 | 33 | 100 |
| 28 | 23 | 23 | 10 | 5 | 2 | 4 | 1 | 32 | 100 |
| 29 | 26 | 21 | 10 | 5 | 2 | 4 | 1 | 31 | 100 |
| 30 | 29 | 20 | 10 | 4 | 2 | 4 | 2 | 29 | 100 |
| 31 | 31 | 19 | 10 | 4 | 2 | 4 | 3 | 28 | 100 |
| 32 | 33 | 18 | 10 | 3 | 2 | 4 | 3 | 27 | 100 |
| 33 | 36 | 18 | 10 | 3 | 2 | 3 | 3 | 25 | 100 |
| 34 | 38 | 18 | 10 | 3 | 2 | 3 | 3 | 23 | 100 |
| 35 | 41 | 18 | 10 | 2 | 2 | 2 | 3 | 22 | 100 |
| 36 | 44 | 17 | 10 | 2 | 2 | 2 | 3 | 20 | 100 |
| 37 | 47 | 17 | 9 | 2 | 1 | 2 | 3 | 19 | 100 |
| 38 | 50 | 17 | 8 | 2 | 1 | 2 | 3 | 17 | 100 |
| 39 | 53 | 17 | 7 | 1 | 1 | 2 | 3 | 16 | 100 |
| 40 | 58 | 17 | 6 | ........ | 1 | 2 | 2 | 14 | 100 |

# TABLE 6.

## PERCENTAGE

OF LUMBER GRADES SAWED OUT OF LOGS WITH THREE TO FIVE DEFECTS.

| Diam. Inches. | 1's and 2's. | Common. | Mill cull. | Dimensions. | Bright saps | Stain'd saps. | Clear strips. | Ship'ng cull. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 25 | 5 | 31 | 14 | 2 | 1 | 3 | 2 | 42 | 100 |
| 26 | 6 | 30 | 13 | 2 | 1 | 4 | 2 | 42 | 100 |
| 27 | 8 | 29 | 12 | 2 | 1 | 4 | 2 | 42 | 100 |
| 28 | 10 | 28 | 12 | 2 | 1 | 4 | 2 | 41 | 100 |
| 29 | 12 | 27 | 11 | 2 | 1 | 4 | 2 | 41 | 100 |
| 30 | 15 | 25 | 11 | 2 | 1 | 4 | 2 | 40 | 100 |
| 31 | 17 | 24 | 11 | 2 | 1 | 4 | 2 | 39 | 100 |
| 32 | 19 | 23 | 11 | 2 | 1 | 3 | 2 | 39 | 100 |
| 33 | 21 | 22 | 11 | 2 | 1 | 3 | 2 | 38 | 100 |
| 34 | 25 | 20 | 10 | 2 | 1 | 3 | 2 | 37 | 100 |
| 35 | 27 | 19 | 10 | 2 | 1 | 3 | 2 | 36 | 100 |
| 36 | 29 | 17 | 10 | 2 | 1 | 3 | 2 | 36 | 100 |
| 37 | 31 | 15 | 10 | 2 | 1 | 3 | 2 | 36 | 100 |
| 38 | 34 | 14 | 9 | 2 | 1 | 3 | 2 | 35 | 100 |
| 39 | 38 | 11 | 8 | 2 | 1 | 3 | 2 | 35 | 100 |

# TABLE 7.

## PERCENTAGE

### Of Lumber Gradfs Sawed Out of Cull Logs.

| Diam. Inches. | 1's and 2's. | Common. | Mill cull. | Dimensions. | Bright saps. | Stain'd saps. | Clear strips. | Ship'ng cull. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 11 | ........ | ........ | ........ | ........ | . . | ........ | ........ | ........ | ........ |
| 12 | ........ | ........ | .... ... | ........ | ........ | ........ | ........ | .... . | ........ |
| 13 | ........ | ........ | ........ | ........ | ........ | ........ | .... | .... | ... .... |
| 14 | ........ | ........ | ........ | ........ | ........ | ........ | .... . | ........ | . .... |
| 15 | ........ | 1 | 7 | 30 | ........ | .... | ........ | 62 | 100 |
| 16 | 0 | 2 | 7 | 28 | 1 | 2 | 1 | 59 | 100 |
| 17 | 1 | 3 | 8 | 26 | 1 | 2 | 1 | 58 | 100 |
| 18 | 1 | 4 | 8 | 26 | 1 | 2 | 1 | 57 | 100 |
| 19 | 1 | 5 | 9 | 25 | 1 | 2 | 1 | 56 | 100 |
| 20 | 2 | 6 | 9 | 25 | 1 | 2 | 1 | 54 | 100 |
| 21 | 2 | 7 | 9 | 25 | 1 | 2 | 1 | 53 | 100 |
| 22 | 3 | 7 | 10 | 24 | 1 | 2 | 1 | 52 | 100 |
| 23 | 3 | 8 | 10 | 23 | 1 | 2 | 1 | 52 | 100 |
| 24 | 4 | 9 | 9 | 23 | 1 | 2 | 1 | 51 | 100 |
| 25 | 4 | 10 | 9 | 22 | 1 | 2 | 1 | 51 | 100 |
| 26 | 5 | 11 | 9 | 21 | 1 | 2 | 1 | 50 | 100 |
| 27 | 5 | 11 | 9 | 21 | 1 | 2 | 1 | 50 | 100 |
| 28 | 6 | 12 | 9 | 20 | 1 | 2 | 1 | 49 | 100 |
| 29 | 6 | 12 | 9 | 20 | 1 | 2 | 1 | 49 | 100 |
| 30 | 6 | 13 | 8 | 20 | 1 | 2 | 1 | 49 | 100 |
| 31 | 7 | 14 | 8 | 19 | 1 | 2 | 1 | 48 | 100 |
| 32 | 7 | 15 | 9 | 19 | 1 | 2 | 1 | 46 | 100 |
| 33 | 8 | 15 | 9 | 18 | 1 | 2 | 1 | 46 | 100 |
| 34 | 9 | 16 | 10 | 17 | ........ | 1 | 1 | 46 | 100 |
| 35 | 9 | 17 | 10 | 16 | ........ | 1 | 1 | 46 | 100 |
| 36 | 10 | 18 | 11 | 15 | ........ | ........ | ..... | 46 | 100 |
| 37 | 10 | 19 | 11 | 14 | ....... | ........ | .... ... | 46 | 100 |
| 38 | 11 | 20 | 11 | 12 | ........ | ....... | .... ... | 46 | 100 |
| 39 | 11 | 21 | 12 | 10 | .... ... | ........ | ........ | 46 | 100 |
| 40 | 12 | 22 | 12 | 8 | ........ | ........ | ........ | 46 | 100 |

# NOTES TO TABLE 8, TABLE 9, TABLE 10, TABLE 11.

It is highly important for every millman to know the actual cash value of the lumber in a given log.

In order to get the necessary information, the various percentages of lumber grades contained in a log of a given description (see tables 4, 5, 6 and 7,) were multiplied by their respective yard prices, which at the time of my investigations were assumed to be the following per 1000 feet board measure:

| | |
|---|---|
| 1s and 2s, | $21. |
| Bright saps, | $16. |
| Clear strips, | $16. |
| Stained saps, | $12. |
| Common, | $12. |
| Dimension stuff, | $6.50. |
| Shipping cull, | $6.50. |
| Mill cull, | $5. |

Of course the prices of any product are subject to variation, according to times and localities. However, the following tables may still be applied with slight modifications, if the prices rise 10 per cent. higher or fall 5 per cent. lower. A child can make the necessary corrections.

The tables will lose their value only when the different grades of lumber show a decidedly divergent tendency of change for better or worse; when, for instance, 1s and 2s gain 10 per cent., whilst common and cull lose 10 per cent.

The "Values of lumber sawed out of logs" are grouped in four tables, according to the four grades of logs distinguished.

Table 8 shows the values of lumber from logs free from defects.

Table 9 shows the values of lumber from logs with one or two defects well located.

Table 10 shows the values of lumber from logs with three to five defects well located.

Table 11 shows the values of lumber from cull logs.

# TABLE 8.

## VALUE

### Of Lumber Actually Sawed Out of Logs Without Any Defects.

PER 1000' B. M. IN DOLLARS.

| Diam. Inches. | 1's and 2's. | Common. | Mill cull. | Dimensions | Bright saps. | tain'd saps. | Clear strips. | Ship'ng cull. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 11 | ........ | ........ | $2.00 | .. ..... | ........ | ........ | ........ | $3.90 | $ 5.90 |
| 12 | ........ | ........ | 1.40 | ........ | $0.32 | .... ... | .. .... | 4.55 | 6.27 |
| 13 | ........ | $0.24 | 1.25 | ........ | 48 | .... | ........ | 4.55 | 6.52 |
| 14 | ........ | 60 | 1.05 | $0.52 | 48 | $0.24 | ........ | 3.96 | 6.85 |
| 15 | $0 42 | 1.32 | 1.00 | 45 | 64 | 24 | ........ | 3.51 | 7.58 |
| 16 | 1.26 | 1.68 | 90 | 19 | 80 | 60 | $0.16 | 3.12 | 8.71 |
| 17 | 2.10 | 2.16 | 80 | 06 | 80 | 60 | 16 | 2.86 | 9.54 |
| 18 | 2.73 | 2.40 | 75 | 06 | 80 | 60 | 16 | 2.60 | 10.10 |
| 19 | 3.36 | 2.52 | 70 | 06 | 80 | 60 | 32 | 2.34 | 10.70 |
| 20 | 4.20 | 2.64 | 65 | 06 | 80 | 60 | 32 | 2.08 | 11.35 |
| 21 | 5.04 | 2.52 | 60 | 06 | 80 | 60 | 32 | 1.95 | 11.89 |
| 22 | 5.67 | 2.40 | 55 | 06 | 80 | 60 | 48 | 1.82 | 12.38 |
| 23 | 6.51 | 2.28 | 50 | 06 | 80 | 60 | 48 | 1.69 | 12.92 |
| 24 | 7.35 | 2.04 | 50 | 06 | 80 | 60 | 48 | 1.56 | 13.39 |
| 25 | 7.98 | 1.92 | 50 | 06 | 80 | 60 | 48 | 1.43 | 13 77 |
| 26 | 8.61 | 1.80 | 50 | 06 | 80 | 60 | 48 | 1 30 | 14.15 |
| 27 | 9.24 | 1.68 | 45 | 13 | 64 | 60 | 48 | 1.23 | 14.45 |
| 28 | 9.87 | 1.56 | 45 | 13 | 48 | 60 | 48 | 1.17 | 14.74 |
| 29 | 10.29 | 1.44 | 45 | 13 | 48 | 60 | 48 | 1.10 | 14.97 |
| 30 | 10.92 | 1.32 | 45 | 19 | 32 | 60 | 48 | 98 | 15.26 |
| 31 | 11.55 | 1.20 | 40 | 19 | 32 | 60 | 48 | 91 | 15.65 |
| 32 | 11.97 | 1.20 | 40 | 13 | 32 | 60 | 48 | 84 | 15.94 |
| 33 | 12.39 | 1.20 | 40 | 13 | 32 | 60 | 32 | 78 | 16.14 |
| 34 | 13 02 | 1.08 | 40 | 06 | 32 | 48 | 32 | 78 | 16.46 |
| 35 | 13.44 | 1.08 | 40 | ........ | 32 | 48 | 32 | 71 | 16.75 |
| 36 | 13.65 | 1.08 | 40 | ........ | 32 | 48 | 32 | 65 | 16.90 |
| 37 | 13.86 | 1.08 | 40 | ........ | 16 | 48 | 32 | 65 | 16.95 |
| 38 | 14.28 | 1.08 | 35 | ........ | 16 | 48 | 32 | 58 | 17.25 |
| 39 | 14.49 | 96 | 35 | ........ | 16 | 48 | 32 | 58 | 17.34 |
| 40 | 14.91 | 96 | 30 | ........ | 16 | 48 | 32 | 52 | 17.65 |
| 41 | 15.12 | 96 | 30 | ........ | ........ | 60 | 32 | 45 | 17.75 |
| 42 | 15.33 | 96 | 30 | ........ | ........ | 60 | 32 | 45 | 17.96 |
| 43 | 15.54 | 84 | 30 | ........ | .... | 60 | 32 | 39 | 17.99 |
| 44 | 15.96 | 84 | 25 | ........ | ........ | 60 | 32 | 32 | 18.29 |

# TABLE 9.

## VALUE

### Of Lumber Actually Sawed Out of Logs With One or Two Defects.

PER 1000′ B. M., IN DOLLARS.

| Diam. Inches. | 1's and 2's. | Common. | Mill cull. | Dimensions. | Bright saps. | Stain'd saps. | Clear strips. | Ship'ng cull. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 15 | $ 0.42 | $1.68 | $1.25 | | ........ | $0.12 | ........ | $3 77 | $ 7.24 |
| 16 | 63 | 1.80 | 1.10 | $0.13 | ........ | 36 | ........ | 3.57 | 7.59 |
| 17 | 1.05 | 2.04 | 90 | 13 | ....... | 36 | $0.16 | 3.51 | 8.15 |
| 18 | 1.26 | 2.16 | 80 | 13 | ........ | 36 | 16 | 3.38 | 8.25 |
| 19 | 1 68 | 2 28 | 75 | 13 | ........ | 36 | 16 | 3.25 | 8.61 |
| 20 | 1.89 | 2.40 | 70 | 32 | ... .... | 36 | 16 | 3.12 | 8.95 |
| 21 | 2 10 | 2.52 | 70 | 26 | $0.16 | 36 | 16 | 2.99 | 9.25 |
| 22 | 2.52 | 2.52 | 65 | 32 | 16 | 36 | 16 | 2.86 | 9.55 |
| 23 | 2.94 | 2.64 | 60 | 32 | 16 | 36 | 16 | 2.73 | 9.91 |
| 24 | 3.36 | 2.64 | 55 | 39 | 16 | 36 | 16 | 2.60 | 10.22 |
| 25 | 3.78 | 2.88 | 50 | 39 | 16 | 36 | 16 | 2.40 | 10.63 |
| 26 | 3 99 | 2.88 | 50 | 39 | 32 | 36 | 16 | 2.27 | 10.87 |
| 27 | 4.41 | 2.88 | 50 | 39 | 32 | 36 | 16 | 2.14 | 11.16 |
| 28 | 4.83 | 2.76 | 50 | 32 | 32 | 48 | 16 | 2.08 | 11.45 |
| 29 | 5.46 | 2.52 | 50 | 32 | 32 | 48 | 16 | 2.01 | 11.78 |
| 30 | 6.09 | 2.40 | 50 | 26 | 32 | 48 | 32 | 1.88 | 12.25 |
| 31 | 6.41 | 2.28 | 50 | 26 | 32 | 48 | 48 | 1.82 | 12.55 |
| 32 | 6.93 | 2.16 | 50 | 19 | 32 | 48 | 48 | 1.76 | 12.82 |
| 33 | 7.56 | 2.16 | 50 | 19 | 32 | 36 | 48 | 1.63 | 13.20 |
| 34 | 7.98 | 2.16 | 50 | 19 | 32 | 36 | 48 | 1.49 | 13.48 |
| 35 | 8.61 | 2.16 | 50 | 13 | 32 | 24 | 48 | 1.43 | 13.87 |
| 36 | 9.24 | 2.04 | 50 | 13 | 32 | 24 | 48 | 1.30 | 14.25 |
| 37 | 9.87 | 2.04 | 45 | 13 | 16 | 24 | 48 | 1.23 | 14.60 |
| 38 | 10.50 | 2.04 | 40 | 13 | 16 | 24 | 48 | 1.10 | 15.05 |
| 39 | 11 13 | 2.04 | 35 | 06 | 16 | 24 | 48 | 1.04 | 15.50 |
| 40 | 12.18 | 2.04 | 30 | ........ | 16 | 24 | 32 | 91 | 16.15 |

# TABLE 10.

## VALUE

### Of Lumber Sawed Out of Logs With Three to Five Defects.

PER 1000′ B. M., IN DOLLARS.

| Diam. Inches. | 1's and 2's. | Com-mon. | Mill cull. | Dimen-sions. | Bright saps. | Stain'd saps. | Clear strips | Ship'ng culls. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 25 | $1.05 | $3.72 | $0.70 | $0.13 | $0.16 | $0.36 | $0.32 | $2 73 | $ 9.17 |
| 26 | 1.26 | 3.60 | 65 | 13 | 16 | 48 | 32 | 2.73 | 9.33 |
| 27 | 1.68 | 3.48 | 60 | 13 | 16 | 48 | 32 | 2.73 | 9.58 |
| 28 | 2.10 | 3.36 | 60 | 13 | 16 | 48 | 32 | 2.66 | 9.81 |
| 29 | 2 52 | 3.24 | 55 | 13 | 16 | 48 | 32 | 2.66 | 10.06 |
| 30 | 3.15 | 3.00 | 55 | 13 | 16 | 48 | 32 | 2.60 | 10.39 |
| 31 | 3.57 | 2.88 | 55 | 13 | 16 | 48 | 32 | 2.53 | 10.62 |
| 32 | 3.99 | 2.76 | 55 | 13 | 16 | 36 | 32 | 2.53 | 10.80 |
| 33 | 4.41 | 2.64 | 55 | 13 | 16 | 36 | 32 | 2.47 | 11.04 |
| 34 | 5.25 | 2.40 | 50 | 13 | 16 | 36 | 32 | 2.40 | 11.52 |
| 35 | 5.67 | 2.28 | 50 | 13 | 16 | 36 | 32 | 2.34 | 11.76 |
| 36 | 6.09 | 2.04 | 50 | 13 | 16 | 36 | 32 | 2.34 | 11.94 |
| 37 | 6.51 | 1.80 | 50 | 13 | 16 | 36 | 32 | 2.34 | 12.12 |
| 38 | 7.14 | 1.68 | 45 | 13 | 16 | 36 | 32 | 2.27 | 12.51 |
| 39 | 7.98 | 1.32 | 40 | 13 | 16 | 36 | 32 | 2.27 | 12.94 |

# TABLE II.

## VALUE

### OF LUMBER ACTUALLY SAWED OUT OF CULL LOGS.

PER 1000′ B. M., IN DOLLARS.

| Diam. Inches. | 1's and 2's. | Common. | Mill cull. | Dimensions. | Bright saps. | Stain'd saps. | Clear strips. | Ship'ng cull. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 15 | ........ | $0.12 | $0 35 | $1.95 | ........ | .. .... | .... | $4.03 | $6.45 |
| 16 | ........ | 24 | 35 | 1.82 | $0.16 | $0.24 | $0.16 | 3.83 | 6.80 |
| 17 | $0.21 | 36 | 40 | 1.69 | 16 | 24 | 16 | 3.77 | 6.99 |
| 18 | 21 | 48 | 40 | 1.69 | 16 | 24 | 16 | 3.70 | 7.04 |
| 19 | 21 | 60 | 45 | 1.62 | 16 | 24 | 16 | 3.64 | 7.08 |
| 20 | 42 | 72 | 45 | 1.62 | 16 | 24 | 16 | 3.51 | 7.28 |
| 21 | 42 | 84 | 45 | 1.62 | 16 | 24 | 16 | 3 45 | 7.34 |
| 22 | 63 | 84 | 50 | 1.56 | 16 | 24 | 16 | 3.38 | 7.47 |
| 23 | 63 | 96 | 50 | 1.49 | 16 | 24 | 16 | 3.38 | 7.52 |
| 24 | 84 | 1.08 | 45 | 1.49 | 16 | 24 | 16 | 3.32 | 7.74 |
| 25 | 84 | 1.20 | 45 | 1.43 | 16 | 24 | 16 | 3.31 | 7.79 |
| 26 | 1.05 | 1.32 | 45 | 1.36 | 16 | 24 | 16 | 3.25 | 7.99 |
| 27 | 1.05 | 1.32 | 45 | 1.36 | 16 | 24 | 16 | 3.25 | 7.99 |
| 28 | 1.26 | 1.44 | 45 | 1.30 | 16 | 24 | 16 | 3.18 | 8.19 |
| 29 | 1.26 | 1.44 | 45 | 1.30 | 16 | 24 | 16 | 3.18 | 8.19 |
| 30 | 1.26 | 1.56 | 40 | 1.30 | 16 | 24 | 16 | 3.18 | 8.26 |
| 31 | 1.47 | 1.68 | 40 | 1.23 | 16 | 24 | 16 | 3.12 | 8.46 |
| 32 | 1.47 | 1.80 | 45 | 1.23 | 16 | 24 | 16 | 2.99 | 8.50 |
| 33 | 1.68 | 1.80 | 45 | 1.17 | 16 | 24 | 16 | 2.99 | 8.65 |
| 34 | 1.89 | 1.92 | 50 | 1.10 | ........ | 12 | 16 | 2.99 | 8.68 |
| 35 | 1.89 | 2.04 | 50 | 1.04 | ........ | 12 | 16 | 2.99 | 8.74 |
| 36 | 2.10 | 2.16 | 55 | 97 | ........ | ........ | ........ | 2.99 | 8.77 |
| 37 | 2.10 | 2.28 | 55 | 91 | ..... | ........ | ........ | 2.99 | 8.83 |
| 38 | 2.31 | 2.40 | 55 | 78 | ........ | ........ | ........ | 2.99 | 90.3 |
| 39 | 2.31 | 2.52 | 60 | 65 | ........ | ........ | ........ | 2.99 | 9.07 |
| 40 | 2.52 | 2.64 | 60 | 52 | ........ | ........ | ........ | 2.99 | 9.27 |

## NOTES TO TABLE 12.

The term, "stem analysis," designates a well established method of determining the exact size of a tree in a given year of its life time.

I applied this method, combined with graphical interpolation, to 20 poplar trees, growing on various soils and exposures, and ascertained what logs 12 feet, 14 feet or 16 feet long and scaling 14 inches or more at the small end might have been obtained from each tree when 100, 120, 140, 160, etc., years old. Adding the contents of these logs for a given age and given conditions of growth, I arrived at the data put together in the following table.

By "Conditions of growth" is understood the influence of soil, moisture and exposure upon tree growth.

Yield tables, such as table 12, have only a local value. There cannot be any doubt that the growth of yellow poplar in Crockett County, Tennessee, far excels that in Henderson and Transylvania Counties of Western North Carolina, for which table 12 and all the following tables based thereon are claimed to hold good.

Under average conditions of growth, trees less than 140 years old, and under poor conditions of growth trees less than about 220 years old are not fit for the saw.

Trees scaling 1000 feet B. M. can be grown only in the course of at least two centuries.

The annual growth of a tree from its 150th year on, generally speaking, amounts to about 10 feet B. M.

# TABLE 12.

MERCHANTABLE CONTENTS OF A SOUND TREE IN FEET BOARD MEASURE, ARRANGED ACCORDING TO AGE OF TREE.

| Age years. | Under good conditions of growth. | Under average conditions of growth. | Under poor conditions of growth. |
|---|---|---|---|
| | feet. | feet. | feet. |
| 120 | 120 | ...... .......... | ................. |
| 140 | 294 | 50 | ................. |
| 160 | 516 | 202 | ................. |
| 180 | 800 | 380 | ................. |
| 200 | 1070 | 561 | ................. |
| 220 | ............ ..... | 746 | 120 |
| 240 | ................. | 924 | 244 |
| 260 | ................. | 1120 | 370 |
| 280 | ................. | ................. | 490 |

# NOTES TO TABLE 13.

Under given conditions of growth, a tree will show a certain diameter at a given age. The relation between age and diameter at 4 feet from ground (breastheight) is given on table 13.

The diameter of a poplar, 4 feet from ground, grows at the rate of 3 inches in 20 years from its 40th to its 100th year. Thereafter the rate of diameter growth becomes gradually less, being about 2 inches in 20 years at the age 200.

This rule can be considered to be correct for average conditions of growth in Western North Carolina.

# TABLE 13.

DIAMETER WITHOUT BARK ATTAINED BY YELLOW POPLAR 4 FEET FROM GROUND.

| In years. | Under good conditions of growth. | Under average conditions of growth. | Under poor conditions of growth. |
|---|---|---|---|
| | Inches. | Inches. | Inches. |
| 40 | 5.7 | 4.0 | 2.3 |
| 60 | 9.5 | 7.1 | 4.5 |
| 80 | 12.8 | 10.2 | 6.7 |
| 100 | 16.0 | 13.3 | 9.0 |
| 120 | 18.8 | 15.9 | 11.1 |
| 140 | 21.3 | 18.2 | 13.2 |
| 160 | 23.5 | 20.4 | 15.1 |
| 180 | 25.7 | 22.4 | 17.0 |
| 200 | 27.7 | 24.3 | 18.5 |
| 220 | 29.6 | 26.0 | 20.0 |

# NOTES TO TABLE 14.

Table 14 is computed from table 12 and table 13 so as to show what quantity of lumber, in feet board measure, a sound tree may be expected to contain on an average when its diameter 4 feet from ground and freed from bark, reaches a given number of inches.

The volme-increment of a tree does not run parallel to the diameter-increase. A diameter-increase of 2 inches corresponds with a volume-increment of about 125 feet B. M. in the case of trees 18 inches through, and of about 250 feet B. M. in the case of trees about 27 inches through. In others words, whilst a tree 18 inches through adds 125 feet B. M. to its volume by growing 2 inches larger, a tree 27 inches through adds about 250 feet B. M. to its volume when growing 2 inches larger at breastheight.

# TABLE 14.

MERCHANTABLE CONTENTS OF A SOUND TREE IN FEET BOARD MEASURE ARRANGED ACCORDING TO DIAMETER OF TREE 4 FEET FROM GROUND.

| If the diameter at 4 feet from the ground measures: | Under good conditions of growth. | Under average conditions of growth. | Under poor conditions of growth. |
|---|---|---|---|
| Inches. | Feet. | Feet. | Feet. |
| 18 | 82 | 60 | .... |
| 20 | 216 | 186 | .... |
| 22 | 370 | 340 | 280 |
| 24 | 584 | 520 | 465 |
| 26 | 838 | 744 | .... |
| 28 | 1120 | .... | .... |

# NOTES TO TABLE 15.

Table 15 is computed from table 12 and table 8, deducting from the values of logs given on the latter all expenses incurred for converting standing trees into lumber ready for shipment. These expenses, on Mr. Vanderbilt's property, amount to from $9 to $11 per 1000 feet B. M., according to the circumstances prevailing in the different sections of the huge tract.

Example: Under average conditions of growth, a poplar tree, which can be logged and sawed and handled at an expense of $11 per 1000 feet B. M. is worth 109 cents at the age of 220 years, and 330 cents at the age of 260 years.

The market value of a tree is negative, if the aggregate logging and milling expenses to be spent on it are in excess of the value of the lumber obtainable from it.

The following tables have reference only to sound trees free from defects. Logically, I ought to give the observations contained in these tables for trees with one or two defects, for trees with three to five defects, and for trees containing cull logs only, as well. However, calculations and mere figures are annoying enough, and I anticipate the wish of the reader, to have such statements curtailed as much as possible.

As appears from table 8, the lumber in logs 16 inches through at the small end is worth $8.71 per 1000 feet.

In logs 17 inches through at the small end it is worth $9.54 per 1000 feet.

In logs 19 inches through at the small end it is worth $10.70 per 1000 feet.

Therefore, where the logging and milling expenses are $9 per 1000 feet, logs 16 inches through ought not to be held out; whilst where they are $10, logs 17 inches through, and where they are $11, logs 19 inches through ought not to be cut, their value being negative.

On the other hand, it appears from the notes to table 12 that I included logs of 14 inches diameter when computing the volume of my trees, and the values of table 15 are based on the same understanding. It would lead me too far to defend the course actually adopted. Suffice it to state, that the correctness of the following tables is scarcely affected by it.

# TABLE 15.

MARKET VALUE OF POPLAR STUMPAGE IN WESTERN NORTH CAROLINA, PER TREE, IN CENTS.

| At the age of years. | Under good conditions. Logging and milling expenses being per 1000 feet B. M. | | | Under average conditions. Logging and milling expenses being per 1000 feet B. M. | | | Under poor conditions. Logging and milling expenses being per 1000 feet B. M. | | |
|---|---|---|---|---|---|---|---|---|---|
| | $9. | $10. | $11. | $9. | $10. | $11. | $9. | $10. | $11. |
| 100 | Negative. | Negative. | Negative. | Negative. | Negative. | Negative. | Negative. | Negative. | Negative. |
| 120 | 8 | " | " | " | " | " | " | " | " |
| 140 | 40 | 25 | " | 4 | " | " | " | " | " |
| 160 | 105 | 72 | 2 | 22 | 5 | " | " | " | " |
| 180 | 265 | 170 | 98 | 67 | 35 | " | " | " | " |
| 200 | 445 | 325 | 230 | 160 | 103 | 30 | " | " | " |
| 220 | 620 | 465 | 350 | 287 | 200 | 109 | 7 | " | " |
| 240 | | | . | 430 | 330 | 210 | 27 | 8 | " |
| 260 | | . | | . | 460 | 330 | 60 | 25 | " |
| 280 | . | | . | | . | . | . | 45 | " |
| 300 | | . | | . | | | | . | 5 |
| 320 | . | . | . | | | . | . | | 30 |

FOOT NOTE: Dots below a column of figures indicate higher values, not specifically ascertained.

The values above the columns of figures are all negative and were not ascertained specifically either.

## NOTES TO TABLE 16.

It depends entirely on the individual judgment of the forest proprietor whether he is satisfied with annual interest of 2 per cent. or 3 per cent. or 4 per cent., etc.

Of course, for forestry as well as for any other business, the rule holds good, that "high interest" on capital invested "means bad security"—the quotation is from the Duke of Wellington.

From tree-growth, to judge from 100 years experience abroad, it is impossible to obtain a constant return of more than 3 per cent. compound interest. Trees do not grow quickly, and if shorter rotations yielding seemingly higher returns were generally attempted, the market would soon be flooded with lumber of low grade, the output from young trees.

To my individual judgment, an expected yield of 3 per cent. appeals most, as such a yield can certainly be secured year after year. Therefore, I consider a tree of that age and that diameter "mature" which yields in annual growth a return of 3 per cent. on its stumpage value.

The diameters in breastheight at this "age of maturity" are shown on the following table.

Where the logging and milling expenses are low, and where the conditions of growth are poor, trees of smaller size must be considered mature, than would be the case under reverse circumstances.

Previous to the age of maturity the annual growth of a tree amounts to more than 3 per cent. of its stumpage value.

After the age of maturity the annual growth of a trec amounts to less than 3 per cent. of its stumpage value. (Compare table 17.)

# TABLE 16.

DIAMETER OF SOUND POPLAR TREES, 4 FEET FROM GROUND, WITHOUT BARK, AT AGE OF MATURITY.

---

(1). Under good conditions of growth :

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| When | logging | and | milling | expenses | are $ | 9. | per | 1000 ft. | B.M. | 25.7 | inches. |
| " | " | " | " | " | " | 10. | " | " | " | 26.7 | " |
| " | " | " | " | " | " | 11. | " | " | " | 27.7 | " |

---

(2). Under average conditions of growth :

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| When | logging | and | milling | expenses | are $ | 9. | per | 1000 ft. | B.M. | 25.2 | inches. |
| " | " | " | " | " | " | 10. | " | " | " | 26.1 | " |
| " | " | " | " | " | " | 11. | " | " | " | 27.0 | " |

---

(3). Under poor conditions of growth :

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| When | logging | and | milling | expenses | are $ | 9. | per | 1000 ft. | B.M. | 22.9 | inches. |
| " | " | " | " | " | " | 10. | " | " | " | 23.7 | " |
| " | " | " | " | " | " | 11. | " | " | " | ........... | |

# NOTES TO TABLE 17.

The table shows, what percentage on the stumpage value of a tree the wood owner derives annually by allowing the tree to live on at a given age. The calculation is based entirely on the data of table 15.

Example: Where the logging and milling expenses amount to $10 per 1000 feet B. M., a poplar growing under good conditions yields by its annual increment, from the 180th to the 200th year of its life, 3 per cent. interest. After that time it ought to be cut down, as the increment will fall below 3 per cent. (Compare notes to table 16.)

Rule 1. A tree is financially ripe for the axe when its annual increment no longer yields more than 3 per cent. interest on its stumpage value.

2. The better the conditions of growth and the smaller the logging and milling expenses are, the sooner is a tree ripe for the axe.

3. The annual interest on the stumpage value of a poplar tree furnished by its annual growth is very high, whilst it is young—certainly more than 8 per cent. in the case of trees less than 120 years old.

4. With the advancing age of a tree, the annual interest on its stumpage value decreases. It stands above zero, however, as long as the tree lives undamaged.

5. The value of a tree is still increasing at the rate of at least $1\frac{1}{2}$ per cent., under good conditions, when the tree is 200 years old; under average conditions, when the tree is 250 years old; under poor conditions when the tree is about 300 years old.

# TABLE 17.

ANNUAL INTEREST ON POPLAR STUMPAGE, PER TREE, TO BE OBTAINED FROM THE ANNUAL GROWTH.

| During years of age of tree | Under good conditions. Logging and milling expenses per 1000 feet B. M. being, | | | Under average conditions Logging and milling expenses per 1000 feet B. M. being, | | | Under poor conditions Logging and milling expenses per 1000 feet B. M. being, | | |
|---|---|---|---|---|---|---|---|---|---|
| | $9. | $10. | $11. | $9. | $10. | $11. | $9. | $10. | $11. |
| | % | % | % | % | % | % | % | % | % |
| 120 to 140 | 8 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 140 to 160 | 5 | 5½ | ........ | 8½ | ........ | ........ | ........ | ........ | ........ |
| 160 to 180 | 4½ | 4½ | .. | 6 | 10 | ........ | ........ | ........ | ........ |
| 180 to 200 | 2½ | 3 | 4½ | 4½ | 6 | ........ | ........ | ........ | ........ |
| 200 to 220 | 1½ | 1½ | 2 | 8 | 3½ | 6 | ........ | ...... | ........ |
| 220 to 240 | ........ | ........ | ........ | 2 | 2½ | 3 | 7 | ........ | ........ |
| 240 to 260 | ........ | ........ | ........ | ........ | 1½ | 1½ | 4 | 11 | ........ |
| 260 to 280 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 3 | ........ |
| 280 to 300 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 300 to 320 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 9 |

FOOT NOTE: Dots above a column of figures indicate higher interest; and dots below a column of figures indicate lower interest not ascertained specifically.

## NOTES TO TABLE 18.

We all know, that a young colt has some value in spite of its present unfitness for service.

An immature tree likewise has a value, which is arrived at by calculation backwards at 3 per cent. compound interest on the value of the mature tree. For instance, under good conditions of growth, (logging and milling expenses estimated to be $10 per 1000 feet B. M.) a sound poplar tree is mature at 190 years, being worth $2.47 at that age. The value of a tree only 100 years old, under similar circumstances, will be found to be $\frac{247}{1.03^{90}} = 17.2$ cents.

In Germany, this value of immature trees is called rather awkwardly the "expectation value."

The stumpage value of a poplar 100 years old is negative, as appears from table 15. The wood owner will lose money when cutting and logging a tree 100 years old. Besides, he will meet a "lucrum cessans," or will give up a possible profit of 17.2 cents, obtainable if he would allow the tree to grow 190 years old.

The stumpage value of trees before they have reached the age of financial maturity is below their expectation value.

# TABLE 18.

PRESENT VALUE OF IMMATURE SOUND POPLAR TREES, IF ALLOWED TO GROW UP TO ECONOMIC MATURITY, IN CENTS.

| At the age of years | Under good conditions. Logging and milling expenses being, | | | Under average conditions Logging and milling expenses being, | | | Under poor conditions. Logging and milling expenses being, | | |
|---|---|---|---|---|---|---|---|---|---|
| | $9. | $10. | $11. | $9. | $10. | $11. | $9. | $10. | $11. |
| 20 | 2.3 | 1.6 | 1.1 | 0.8 | 0.5 | 0.3 | | . | . |
| 40 | 4.2 | 2.9 | 2.0 | 1.5 | 1.0 | 0.6 | 0.1 | . | . |
| 60 | 7.7 | 5.3 | 3.7 | 2.7 | 1.8 | 1.0 | 0.1 | . | . |
| 80 | 13.8 | 9.7 | 6.6 | 4.8 | 3.2 | 1.9 | 0.3 | 0.1 | . |
| 100 | 24.9 | 17.2 | 11.9 | 8.6 | 5.7 | 3.4 | 0 5 | 0.2 | . |
| 120 | 45.0 | 31.1 | 21.6 | 15 6 | 10.4 | 6.1 | 0.8 | 0.4 | . |
| 140 | 82.1 | 56.7 | 39.4 | 28.5 | 18.9 | 11.1 | 1.5 | 0.8 | . |
| 160 | 145.7 | 101.0 | 69.8 | 50.6 | 33.5 | 19.8 | 2.7 | 1.3 | . |
| 180 | . | 183.0 | 127.0 | 92.0 | 61.0 | 36.0 | 5.0 | 2.5 | . |
| 200 | . | . | . | 167.0 | 111.0 | 66.0 | 10.0 | 5.0 | . |
| 220 | . | . | . | . | . | 119.0 | 18.0 | 8.0 | . |
| 240 | . | . | | . | . | . | 33.0 | 15.0 | . |
| 260 | . | . | . | . | . | . | | 27.0 | . |

## NOTES TO TABLE 19.

The table gives the difference between the present value of the expected yield of immature trees and their actual stumpage value. (Expectation value minus market value.)

The breeder of horses will never think of selling a colt for the value of its hide and flesh. No doubt he will ask a price proportionate to the expected value of the full grown horse.

Why does the tree grower act differently?

Example: The wood owner, who allows a tree growing under "average conditions of growth" to be cut at the age of 160 years, loses 28.6 cents, in case the logging and milling expenses amount to $9 per 1000 feet B. M.

From its 160th to its 180th year the tree would yield 6 per cent., and from its 180th to its 200th year, 4½ per cent. compound interest. (Table 17). The age of economic maturity for this tree is in the neighborhood of 210 years, when its increment will be about 3 per cent.

# TABLE 19.

## Loss Incurred Through Cutting Trees at too Young an Age, in Cents.

The Wood Owner, who Allows Immature, Sound Poplar Trees to be Cut, Loses for Each Tree :

| If the trees are old : | Under good conditions. Logging and milling expenses being, | | | Under average conditions. Logging and milling expenses being, | | | Under poor conditions. Logging and milling expenses being, | | |
|---|---|---|---|---|---|---|---|---|---|
| | $9. | $10. | $11. | $9. | $10. | $11. | $9. | $10. | $11. |
| | cents. | cents. | cents | cents | cents. | cents. | cents. | cents. | cents |
| 120 | 37.0 | ........ | ........ | ........ | ........ | ....... | ........ | ........ | ........ |
| 140 | 42.1 | 31.7 | ........ | 24.5 | ........ | ........ | ........ | ........ | ........ |
| 160 | 40.7 | 29.0 | 67.8 | 28.6 | 28.5 | . .... | ........ | ........ | ........ |
| 180 | ........ | 13.0 | 29.0 | 25.0 | 26.0 | ....... | ........ | ........ | ........ |
| 200 | ........ | ........ | ........ | 7.0 | 8.0 | 36.0 | ........ | .. .... | . ...... |
| 220 | ........ | ........ | ........ | ........ | ........ | 10.0 | 11.0 | ........ | ........ |
| 240 | ....... | ........ | ........ | ........ | ........ | ........ | 6.0 | 12.0 | ........ |
| 260 | ........ | ........ | .... .. | ........ | ........ | ........ | ........ | 2.0 | ........ |

Foot note : Dots within the columns of figures indicate amounts, which could not be ascertained with sufficient accuracy.

# NOTES TO TABLE 20.

Whilst table 19 states the loss incurred by cutting or selling immature trees according to their respective ages, table 20 is meant to show the unwisdom of cutting trees of too small a diameter.

The calculation is based on the data given by tables 14, 15 and 19.

Example: Under average conditions of growth, (logging and milling expenses being $10,) the owner loses 27.1 cents for every tree which he allows to be cut when only 22 inches through at breastheight, free from bark.

# TABLE 20.

## Loss Incurred Through Cutting Trees of Too Small a Diameter, in Cents.

The Wood Owner, who Allows Immature, Sound Poplar Trees to be Cut, Loses for Each Tree:

| If the diameter at 4 ft. from ground is: inches | Under good conditions. Logging and milling expenses being. | | | Under average conditions. Logging and milling expenses being, | | | Under poor conditions. Logging and milling expenses being, | | |
|---|---|---|---|---|---|---|---|---|---|
| | $9. | $10. | $11. | $9. | $10. | $11. | $9. | $10. | $11. |
| | cents | cents | cents. | cents. | cents. | cents. | cents. | cents. | cents. |
| 18 | 34.2 | ........ | ........ | 23.8 | ........ | ........ | ........ | ........ | ........ |
| 19 | 37.0 | ........ | ........ | 26 8 | ........ | ........ | ........ | ........ | ........ |
| 20 | 40.0 | ........ | ........ | 28.3 | 28.8 | ........ | 11.0 | ........ | ........ |
| 21 | 41.8 | 31.7 | .. | 28.0 | 28.5 | ........ | 7.6 | 16.0 | ........ |
| 22 | 41 8 | 31.2 | ........ | 26.6 | 27.1 | ........ | ........ | 7.0 | ........ |
| 23 | 40.8 | 30.0 | ........ | 19.8 | 21.0 | ........ | ........ | ........ | ........ |
| 24 | ........ | 27.0 | 60.0 | 10.0 | 12.0 | 38.0 | ........ | ........ | ........ |
| 25 | ........ | 21.0 | 43.0 | ........ | ........ | 25.0 | ........ | ........ | ........ |
| 26 | ........ | ........ | 27.4 | ........ | ........ | 10.0 | ........ | ........ | ........ |

FOOT NOTE: Dots within the columns of figures indicate amounts which could not be ascertained with sufficient accuracy.

# LECTURES ON FOREST POLICY

*By* C. A. SCHENCK, PH.D.

Director of the Biltmore Forest School, and Forester to the Biltmore Estate, N. C.

*Second Part:*

"FORESTRY CONDITIONS IN THE UNITED STATES."

Biltmore Forest School,

Directors' Office.

Biltmore, N. C., January 1, 1904.

Dear Sir—My lectures on Forest Policy appear in print, primarily, for the benefit of the students attending the Biltmore Forest School. Forestal text-books fit for American use not being available, I have been forced, for a number of years, to lengthily dictate the essence of my lectures.

The following pages merely record the dictation. They are not intended for public sale.

I most sincerely request, dear sir, that you may lend me your aid in checking and correcting the data concerning your State, namely, ........................., given on page......f. f., so that this little volume, duly filed and controlled by collaborating friends, may thereafter publicly appear, in a better garment and improved contents, for the benefit of the American student of forestry.

Thanking you for any kindness that you may deem fit to show me in connection with the improvement of my lectures on "Forest Policy," I am, dear sir,

Most truly yours,

# LECTURES ON FOREST POLICY

*By* C. A. SCHENCK, Ph.D.

**Director of the Biltmore Forest School, and Forester to the Biltmore Estate, N. C.**

## FORESTRY CONDITIONS OF ALABAMA:

1. Area: 38,300 square miles, or 74% of total area, are wooded.

2. Physiography: The Cumberland Mountains force the Tennessee River into Alabama, where it forms a huge curve. The Appalachian Mountains send a double chain of mountains, in a northeast to southwest direction, from Chattanooga to Birmingham. Tombigby River and Alabama River join just before emptying into Mobile Bay. Chattahoochee River on Georgia line. Southern section of State undulating, swamps alternating with slightly elevated dunes. Mountains near Birmingham bear coal and iron.

3. Distribution: The southern third of the State is occupied by long leaf and Cuban pine; the former on dry, the latter on wet land. Four large isolated tracts of long leaf pine (unaccompanied by Cuban pine) in the northern half of State. Taeda occurs all over the State in varying proportion, accompanying here long leaf, there echinata or hardwoods. Echinata is found, generally, outside the region of Cuban pine and does not proceed to the coast. Best stumpage of echinata on upland, with oak undergrowth. Pine stumpage estimated, in 1880, to be 21 billion feet b. m. Enormous cypress swamps along the rivers. Outside the long leaf pine sections, the hardwoods, notably black, Spanish and post oak, prevail in number, but not in importance. In the curve of the Tennessee River, the southernmost sentinels of the fine hardwood and red cedar forests once typical for Tennes-

see. In the mountain section, the flora of the Cumberland plateau (see under Tennessee), with some little white pine and hemlock.

4. Forest ownership: 525 firms own 1,224,000 acres of forest. The federal government, State railroads and homesteaders are the chief owners.

5. Use of timber: Destructive lumbering only of recent date. Huge deserts are nowhere left by the lumber jack, as is the case in the lake States. No pine resists fire better than long leaf. Cuban pine is protected by its position. The industry threatening ruin to the forests is the turpentine industry, which leaves only taeda intact. The output of the saw mills was in

| | |
|---|---|
| 1880 | $ 2,700,000 |
| 1890 | 8,500,000 |
| 1900 | 12,900,000 |

The cut in 1900 consisted of:—

| | |
|---|---|
| Yellow pine | 1,012,000,000 feet b. m. |
| Other conifers | 32,000,000 feet b. m. |
| White oak | 61,000,000 feet b. m. |
| Other hardwoods | 44,000,000 feet b. m. |
| Total | 1,149,000,000 feet b. m. |

Mill investments average $5,251 with 1,087 mills. Logs on stump are worth $1.20, at mill $4.30 per 1,000 feet b. m. Cooperage stock production, in 1900, is valued at $200,000; miscellaneous sawn products at $400,000; shingles, notably cypress shingles, at $460,000. In 1885, the naval store industry yielded $851,000.

Leather industry surprisingly large, producing, in 18 tanneries, $1,098,000 worth of leather and using 18,651 cords of oak bark, worth $62,628.

Paper and pulp industry: None.

6. Forestry movement: None.

7. Laws: Fire laws of 1852, against wilful or negligent firing. Firing turpentine orchards is under a fine of $100 to $1,000, or punishable with hard labor for not more than 12 months.

8. Reservations: None.

9. Irrigation: 89 acres of land were irrigated, in 1899, for truck farming.

No rice fields enjoyed irrigation.

## FOREST POLICY.

### FORESTRY CONDITIONS OF ALASKA:

1. Area: The total area of Alaska is 590,000 square miles. The area of woodlands can scarcely exceed 60,000 square miles.

2. Physiography: The territory of Alaska forms a square, traversed by the east and west course of the Yukon River and framed by the ocean on three sides, with two appendages, namely:

(a) In the S. W., the Aliaskan Peninsula, with Kadiak and Apognak Islands.

(b) In the S. E., the mountainous coastal belt, 60 miles wide by 500 miles long, with over 1,000 islands (notably Sitka Island) fronting the coast.

Mt. McKinley, in the Alaskan Range, lying somewhat south of the center of the territory, 20,464 feet high, is drained by the Kuskokwim River. The Kuro Shiwo causes abundant (60 inches to 160 inches) rainfall and high atmospheric along the southern coast. Eternal snow, however, lies above the 2,000-foot contour line, even in the coast range and St. Elias Mountains. The mountains are beset with the hugest glaciers on earth, outside the polar region. Short growing season. Geologically, Alaska is one of the latest portions of the continent.

3. Distribution: The south coast, east of Kadiak Island, shows splendid coniferous forests, stocked with Sitka spruce, balsam fir (grandis?) hemlock, red cedar (Thujaplicata) and yellow cedar (Chamaecyparis Nutkaensis). Amongst the hardwoods, cottonwood alone reaches commercial size. Sitka spruce penetrates, in stunted form, to the Arctic Circle.

The hills of the lower Kuskokwim River have little wood; heavy spruce forests, however, exist on the mountain slopes of its upper course, whilst the valleys exhibit splendid summer prairies.

The northwestern hills are bare. Woodlands are found along the west coast up to Norton Sound.

Arctic tundra—a treeless plain full of ponds and swamps—extends from the Yukon northward to the Arctic Ocean. Dwarfed spruces and willows dot it far to the north.

4. Forest ownership: Practically all woodland belongs to the federal government, though the Russian Greek Church may own comparatively small tracts. Lack of surveys prevents land entries.

5. Use of timber: Most lumber is imported from the

Pacific States. Coal (sulphurous) is found in many places, restricting the consumption of wood. The population scarcely exceeds, in 1902, 90,000, of which two-fifths are native.

Yellow cedar is used by the natives for huge dugout canoes. The bark of the balsam fir is employed for tanning. The common local timber tree is the knotty Sitka spruce, used for house building, mine props, sledges and firewood.

The large output of the fish canning industry (over 51,000,000 lbs. salmon in 1899) requires packing crates and slack barrels.

The 12th census reports a cut of 6,500,000 feet b. m. lumber, mostly spruce, valued at $90,000. Much unlawful cutting on vacant timberland.

6. Forestry movement: None.

7. Laws: None.

8. Reservations: The Apognac Forest and Fish Culture Reservation lies north of Kadiak Island and comprises 403,640 acres.

The Alexandria Archipelago Forest Reserve covers 4,506,240 acres.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF ARIZONA:

1. Area: 16,000,000 acres, or 22% of entire area of Territory, are reported under forest.

2. Physiography: Arizona consists of a high plateau, 5,000 feet elevation, sloping gently towards Gulf of California, intersected in northwest by the Grand Cañon, and diagonally traversed from the northwest to the southeast by a chain of mountain ranges, many tops of which rise to 10,000 feet elevation. This chain drains towards west into the Rio Gila and towards east into the Little Colorado, both of which are tributaries of the Colorado River. The rainfall, especially during the summer months, often evaporates before reaching the ground. Streams are frequently smaller at the mouth than at the head, due to dryness of the atmosphere.

3. Distribution: Below 3,500 feet elevation occur deserts, with cactus, yucca and agave. The river cañons are deeply cut into the plateaus and are fringed with broad-leaved species, i. e.,

cottonwoods, willows, alders, ashes, hackberries and cherries. The foothills around the deserts show scattered scrub pines; scrub oaks occur notably on the hillsides; Mesas exhibit stunted oaks and pines. Above 5,500 feet elevation, open, park-like forests occur, notably of yellow pine (ponderosa), which, in the San Francisco Mountains near Flagstaff, are said to form the largest pure pine forest in the world. Trees are short, branchy and sappy. On the northern slopes, at about 6,500 feet elevation, occurs Douglas fir. The Rocky Mountain white pine (P. flexilis) and foxtail pine (P. balfouriana) are found at similar elevations in the San Francisco Mountains. Above them, large, often pure forests of Arizona cypress (Cupressus Arizonica). At the timber line, after Fernow, Engelmann's spruce and Arizona cork fir (Abies Arizonica) occur.

The plateau north of the Colorado Cañon is almost treeless.

A large number of coniferous species peculiar to Arizona are found in the southern part of the diagonal chain. Here the forest forms narrow stretches of fringe at altitudes exceeding 7,000 feet elevation. The best known mountain ranges are the Bradshaw Mountains, with 25 square miles of forest, the lower slopes dotted with nut pines (monophylla and edulis).

The Mazatzal Mountains contain about 70 square miles of forest (yellow pine, white pine, Douglas fir, white fir).

The White Mountains contain about 100 square miles of forest. Here, near the natural bridge, a splendid, almost pure forest of Arizona cypress occurs.

The Chirihahua Mountains contain 160 square miles of forest, a strip four miles wide and forty miles long. The Arizona pine (Pinus Arizonica) and the Chirihahua pine (Pinus Chirihahuana), further, the Mexican pine (Pinus cembroides) and a white pine (Pinus strobiformis) are additions to the tree flora in these southeastern mountains, which otherwise consists of yellow pine (ponderosa), white pine (flexilis), Douglas fir and California white fir (Abies concolor). Between the deserts and forests there is invariably found a belt showing pinons and scrub oaks. Timber species are generally wanting on mountains less than 7,000 feet high.

4. Forest ownership: The United States reserves aggregate, in 1902, 6,740,000 acres. Large Indian reservations, notably the Moqui and Navajo, in the northeast and in the White Moun-

tains. Lumbermen own 409,000,000 feet b. m. yellow pine stumpage on 202,000 acres.

5. Use: Most prominent use of the forest is that for cattle and sheep pasture. Forest fires do little damage, forests being open. Sheep grazing in the reserves from April until December.

Output of lumber industry in 1900 was 36,250,000 feet b. m., worth $547,000. Log stumpage, $1.03. Saw logs at mill, $7.50. Only 14 saw mills, with average capital of $26,000. No pulp or leather industry. Mining industry, near Prescott, obtains supplies from the Bradshaw Mountains. Saw mills turn out largely yellow pine ties. Percentage of 1's and 2's in the lumber not over 7%.

6. The forestry movement in Arizona is nill.

7. Laws: Forest fire laws punish negligent or wilful firing as a misdemeanor.

8. Reservations: The Grand Cañon forest reserve is not a forest reserve proper. It contains forest only south of the Colorado. It occupies 1,851,520 acres.

The Prescott forest reserve covers 423,680 acres; the Black Mesa forest reserve 4,658,880 acres. The latter extends to the New Mexico line, forming a narrow belt of forest at high elevations.

The San Francisco Mountain forest reserve, with Flagstaff in the center, lies between the Grand Cañon and Black Mesa reserves and contains 1,975,310 acres. This reserve will be important for lumbermen in the near future.

In April, 1902, the Santa Rita forest reserve of 387,300 acres was created. In July, 1902, there were created three new reserves, namely:—

Mt. Graham forest reserve (118,600 acres);

Santa Catalina forest reserve (155,520 acres);

Chirihahua forest reserve (169,600 acres).

All reserves lie on the diagonal mountain range referred to, and are well selected.

9. Irrigation: In 1900, 190,000 acres of farm land were irrigated. Area is small, owing to irregularity of precipitations and lack of steady supply. The necessity and, at the same time, the opportunity for farms irrigated from storage reservoirs is great.

Some tribes of Aborigines have irrigated their farms long before the advent of the whites.

Irrigation in the Salt River Valley, near Phoenix, shows results similar to those obtained in southern California. Fruits put on the market slightly earlier and freight rates to the east slightly better, give Arizona a certain advantage over California.

The value of the irrigation works constructed is $4,400,000; the value of the irrigated products $2,200,000 (anno 1899).

---

## FORESTRY CONDITIONS OF ARKANSAS:

1. Area of woodlands 45,000 square miles, equal to 84% of the State. Probably maximum percentage amongst the States.

2. Physiography: Undulating plains. Ozark Mountains traverse northwest corner of the State in a belt 80 miles wide and from 1,000 to 2,000 feet high. Arkansas River traverses State from west to east, joined by the White River close to its junction with the Mississippi. Red River in the southwestern part of the State.

3. Distribution: Forest everywhere. A small tract of prairie in east central part of State. South of the Arkansas River and west of the Mississippi bottom lands gigantic virgin forests of pine occur (echinata and taeda mixed, the former prevailing on pine ridges, the latter prevailing on pine flats). Both pine species sold under the name of "short leaf pine." Stumpage of both species very heavy, say 6,000 feet b. m. per acre. Sargent estimated, in 1880, the stumpage of short leaf pine at 41,315,000,000 feet b. m. per acre. Bald cypress found in vast swamps in the bottom lands of the rivers. Stumpage about 5,000 feet to the acre.

The hardwoods prevail north of the Arkansas River and all along the Mississippi; further, in the bottoms of the Red River. Here the trees are said to be unsurpassed in size. Black walnut is said to be particularly abundant in the valley of the Red River. The leading hardwoods are white and red oaks, cottonwoods, sweet gum, black gum, yellow poplar, beech, ash, hickories, cow and texan oak. Pinus echinata shows some important bodies north of the Arkansas River as well, whilst taeda is here lacking.

The composition of the forest at Pine Bluff, after F. E.

Olmsted, on an average acre, excluding trees of under 12 inches diameter, is as follows:—

| On Pine Land. | | In Hardwood Bottoms. | |
|---|---|---|---|
| Echinata | 5.9 trees | Hickory | 5.8 trees |
| Taeda | 5.3 trees | Cow oak | 4.8 trees |
| White oak | 3.8 trees | White oak | 3.5 trees |
| Post oak | 3.3 trees | Holly | 2.1 trees |
| Black Oak | 0.7 trees | Ash | 1.3 trees |
| Gum | 2.1 trees | Basswood | 0.6 trees |
| Spanish oak | 1.2 trees | Post oak | 0.2 trees |
| Hickory | 0.8 trees | Pines | 1.2 trees |
| Miscellaneous | 0.7 trees | Miscellaneous | 1.5 trees |

Apparently the pines form little over half of the growing stock on pine lands. Hardwoods not marketable on pine land.

4. Forest ownership: 28% of the hardwood land is reported attached to farms. 517 lumber firms own 1,497,000 acres, of 6,700 feet b. m. average stumpage.

5. Use of timber: Logs on stump are worth $1.09, and logs at mill $4.74.

Logging in the pine woods by cattle and high wheel trucks, or by donkey engines. Mill investments, for 738 mills reporting, are $9,224 on an average. The lumber industry has grown very rapidly of late—more so in Arkansas than in any other State of the Union.

| | |
|---|---|
| In 1880 the lumber output was valued at.... | $ 1,800,000 |
| In 1890 the lumber output was valued at.... | 8,900,000 |
| and in 1900 the lumber output was valued at. | 30,000,000 |

The cut in 1900 consisted of:—

| | |
|---|---|
| Cypress | 108,000,000 feet b. m. |
| Yellow pine | 1,113,000,000 feet b. m. |
| Cottonwood | 117,000,000 feet b. m. |
| Red gum | 61,000,000 feet b. m. |
| White oak | 226,000,000 feet b. m. |
| Other hardwoods | 40,000,000 feet b. m. |

Forests are little used for pasture, other than hog pasture. The railroad freight consists largely of lumber and timber. Three small tanneries. No pulp or paper mills.

6. Forestry movement: "To get rid of the lumber" is the only demand. Conservative lumbering attempted near Pine Bluff, since cut-over pine land is scarcely salable.

7. Laws: The usual fire laws are unobserved.

8. Reservations: None, excepting a military reserve at Hot Springs.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF CALIFORNIA:

1. Area: 28,600,000 acres of forest, equal to 22% of area of State.

2. Physiography: The Valley of California, drained by Sacramento from the north and San Joaquin from the south, and embraced by Coast Range and Sierra Range, opens towards bay of San Francisco. Towards the south the Coast Range emits irregular sentinels, notably the Santa Lucia Mountains, San Gabriel Mountains, San Bernardino Mountains, rising up to 10,000 feet elevation. Deserts along the Nevada, Arizona and Oregon line.

3. Distribution: California excels in the number of coniferous species, the variety of forest growth depending on the peculiarities of her climate. Rain winds in southern California are, strange to say, northeast winds. Rainy season begins in September, preceded by three or four months of drought. Coast Range contains no commercial forests south of Santa Cruz. Water courses deep seated, torrents in winter, mere threads in summer, unfloatable.

Immediately along the ocean shore, stunted conifers only grow. Above shore belt, the famous redwood belt of the Coast Range, consisting of Sequoia sempervirens. The redwood belt extends from the Oregon line southward to Santa Cruz; it is composed of large, pure redwood forests, exhibiting greatest stumpage of any tree per acre. Accompanying redwood are found, principally, Douglas fir, yellow pine, sugar pine, incense cedar, tideland spruce and three firs (Abies grandis, magnifica and nobilis), which run up to the crest of the range. The coniferous woods are intersected with tracts where chestnut oak and madrona (Arbutus Menziesii) dot the brush covered slopes. The east slope of the Coast Range, towards the Sacramento Valley, shows a scattering growth of pines and oaks, often imbedded in brush thickets.

The bottom lands of Sacramento and San Joaquin Rivers have a park like growth of huge oaks, which are now rapidly removed by the farmers.

Ascending the Sierras from the west we find the lowest belt, below 2,000 feet elevation, to consist of gray (digger or nut) pine (Pinus sabiniana), the favorite nut tree of the Indians, occurring in very open growth, alternating with oaks and the knob cone pine (Pinus attenuata), which regenerates only under the influence of fire.

The typical tree of the next higher belt, from 2,000 to 4,000 feet elevation, is the nutmeg tree (Tumion Californicum), which is found along the borders of streams. The hillsides show a comparatively poor growth of pine and fir, the Douglas fir being frequently of the "yellow" variety.

Above this zone, from 4,000 to 10,000 feet elevation, extends the famous timber belt of the Sierras. Rainfall is 50 to 60 inches. Typical for the California Sierras is the lack of any woody undergrowth on the ground. The soil is covered with a growth of flowering weeds. Imbedded in this belt are, island-like, ten groves of the big trees (Sequoia gigantea). This species, unlike its sister, the redwood, never grows in pure forests. The companions are Douglas fir, sugar pine, yellow pine, incense cedar and firs (Abies magnifica and concolor).

At elevations ranging between 3,000 and 8,500 feet, incense cedar frequently replaces the big tree. On old burns, lodge pole pine is found in pure stands. Amongst the nut pines, the one-leaf pine is highly thought of by the Indians. In addition, there occur the bull pine (Pinus Jeffreyi) and the big cone pine (Pinus Coulteri).

The highest belt, reaching up to the timber line at 12,000 feet, is the home of the firs proper. Here the red fir (Abies magnifica) and the white fir (Abies concolor) prevail. Timber line itself shows the Alpine hemlock, young trees of which are buried in snow all winter. Pinus monticola, the white pine, is said to excel in power of resistance to storms. The limber white pine (Pinus flexilis) and the white bark pine (Pinus albicaulis) are also found. Two typical species for this zone are the foxtail pine (Pinus Balfouriana) and the bristle cone pine (Pinus aristata).

In addition, twisted pine (Pinus contorta) occurs on high mountain pastures.

Crossing to the east slope of the Sierras, the growth soon gets poorer, for lack of rain. Only pine species are found here, especially lodgepole pine, yellow pine and bull pine. Close to the Nevada line desert growth only occurs, such as mesquit and yucca.

In southern and southwestern California there are scarcely any commercial forests. Along the Arizona and Nevada line the Mohave desert and Colorado desert cover millions of acres. The plains, close to the sea and rivers, have dense groves of willows and sycamores. Majestic oaks occur scatteringly in the river valleys. In addition there are huge cottonwoods. On the edges of the deserts, in slight depressions, two Prosopis species are found, i. e., mesquit (Prosopis juliflora) and screw bean (Prosopis odorata). Piñons or nut pines are also found. The California palm (Washingtonia filifera) is found in canyons opening toward the deserts. In the deserts themselves are scattering yuccas. Ascending the mountain ranges the trail winds through endless chaparral thickets, dotted with live oaks and scrub pines (piñon). Forests occur at high altitudes on the Sierra Madre, San Bernardino, San Gabriel, Cuyamaca and San Jacinto Mountains. Here prevail yellow pine, Coulter's big cone pine, big cone fir (Pseudotsuga macrocarpa), white fir (concolor), in company with sugar pine, incense cedar, lodgepole pine and limber white pine. In the semi-arid zone reaching up to the 5,000-foot contour line are at home juniper, single leaf pine and gray pine, whilst the moister slopes and canyons, or the water courses, exhibit live oak, sycamore, walnut, alder, willow and cottonwood. The bristle cone fir (Abies venusta), a large fir of the canyons, seems unique in the Santa Lucia region.

4. Ownership: Farmers are said to own 1,673,000 acres of forest land. The United States forest reserves cover 8,800,000 acres; the United States parks 1,100,000 acres; both together about one-third of all the forests and 8.6% of the area of the State. According to the last census, 156 lumber firms control 1,177,000 acres of forest land, mostly situated in the Coast Range, and containing one-sixth of the timber of the State.

5. Use: There is scarcely any hardwood fit for cooperage, carriage works and furniture. Firewood is costly in southern California. Large lumber operations are conducted on the Coast

Range only, supplying South America and the far east. Here a yield of 1,000,000 feet b. m. per acre is amongst the possibilities. Logging is done by railroad and donkey engines. Commercial species, aside from redwood, are sugar pine, Douglas fir, incense cedar and red fir (Abies magnifica). Redwood is said to furnish the best tank material and railroad ties, if tie plates are used. From the Sierras, lumber is exported into Nevada and Arizona for the use of the mines.

The Alpine meadows of the Sierras offer good pasture, but are said to suffer severely from sheep pasture. Regeneration in Sierra belt is said to be poor, no undergrowth being at hand. On old clearings, near mines, sugar pines and yellow pines are said to show a good second growth.

The tannin industry of California occupies the tenth rank among the States, using during the last census year 36,123 cords of chestnut oak bark, valued at $16 per cord. Production is largely sole leather.

The paper and pulp industry is nill, five plants having died during the last decade.

The products of the lumber industry were worth:—

| | |
|---|---|
| In 1850 ............. | 0.9 million dollars. |
| In 1870 ............. | 5.2 million dollars. |
| In 1890 ............. | 8.8 million dollars. |
| In 1900 ............. | 13.8 million dollars. |

The total cut in the census year was only 864 million feet b. m., drawn from a growing stock of 36 billion feet b. m., owned by private individuals. Log stumpage is worth $1.16. Logs at mill are worth $4.63. California leads in the use of traction engines, which are employed on undulating ground. The mill establishments are large, next in size to those of Minnesota and Wisconsin, the investments averaging $29,300. Eucalyptus plantations are made in the timberless regions of the south to obtain posts and firewood. Species recommended are: Eucalyptus globulus, rostrata, viminalis, corynocabyx, leucoxylon.

6. Forestry movement: California has been sensible of the dangers threatening from forest destruction and forest fires, since agriculture depends largely on the possibility of irrigation, safeguarded by forests. A State Board of Forestry was established in 1885, drawing a good appropriation, writing some valuable re-

ports and establishing some experiment stations. In 1891, political decrepitude caused the board to lose its foothold. A prominent member of the board was Abbot Kinney. To him is due the introduction of Eucalyptus.

The tree botany of the State has been advanced by J. G. Lemmon. The California legislature has memorialized the United States government to set aside all forests for reserves. When, in 1897, all western reservations were opened to pasture by Binger Hermann, the California senators opposed the move and secured exemption for their State. At the university of South-California a forestry school was established in 1899. The Sierra Club (John Muir, President) and the California Water and Forest Association (since 1898) are taking up the work of the defunct State board. Sheep owners are the only people in California opposing the forest reserve policy.

7. Laws: The usual fire laws. The State Board of Forestry demanded of Congress, but in vain:—

(a) The temporary repeal of the timber and stone act.

(b) A law providing for sale of stumpage only from forest land, the government retaining the fee simple rights. State law of 1903 appropriates $15,000 to assist the Bureau of Forestry in a canvass of the forest resources.

8. Reservations: The total area reserved, in 1902, is 8.8 million acres. The reserves are well selected, covering the tops of the Sierra Nevada and the high mountain ranges of the south. No reserves on the Coast Range.

The Sierra forest reserve, aggregating 4,096,000 acres, lies south of the Yosemite National Park, is about 200 miles long by 50 wide and comprises the Sequoia National Park, General Grant National Park and Mount Whitney Military Reservation. North of the Yosemite National Park lies the Stanislaus forest reserve, covering 691,200 acres. The Lake Tahoo forest reserve, of 136,335 acres, is the only reserve drained by the Sacramento. The highest summits of the Sierras are in the reserves. 85% of the reserves are timbered and 15% are covered with snow or glaciers. 70% of the 85% have, however, suffered from fire.

The southern reserves form links in a long chain running, approximately, east and west, and consist of the

Pine Mountain and Zaca Lake forest reserve (1,644,594 acres).

San Gabriel Timberland reserve (155,520 acres).
Santa Ynez forest reserve (145,000 acres).
San Bernardino forest reserve (737,280 acres).
Trabuco Cañon forest reserve (109,920 acres).
San Jacinto forest reserve (668,160 acres).

The reserves were established solely to protect the water supply. The brush thickets occupy from 50% to 90% of the reserved tracts.

The Yosemite National Park comprises the Yosemite Valley, which was ceded to California by Congress in 1854, and is now in charge of three commissioners said to be lacking in good taste.

9. Irrigation: Value of products from irrigated land exceeds those in any other State. The average size of the irrigated farms is 75 acres. Cost per acre of irrigation system is $16.80 and average yearly cost is $1.70. In 1903 the State appropriates $45,000 to assist federal departments in mapping and surveying reservoirs and in studying methods of water distribution.

The "district law" of 1887 causes great ease in bonding irrigation districts, and hence throws heavy burdens on the irrigationists. Many of the bonds issued are now worthless.

The irrigation systems were constructed at an expense of $19,200,000.

Irrigation in the north is rather the exception. In the south it forms the rule. Along the Sierra streams, water is lavishly used. In the south, the greatest economy prevails.

Shipments of oranges raised in the south, in 1899, were $7,000,000 in value.

In 1899, 1,600,000 acres were irrigated. Value of irrigated crops was $33,000,000.

Irrigation prevails, where the precipitations and the flowage of streams are least; on the other hand, where there is no danger from frost.

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## FORESTRY CONDITIONS OF COLORADO:

1. Area: 33,500 square miles of woodland, or 32% of the area of the State.

2. Physiography: The 105th meridian separates the eastern

third from the western two-thirds of the State. The eastern third is a treeless plateau, falling from 6,000 to 4,000 feet, towards the Kansas State line. Little rainfall. The central third of the State is the crest of the continent and is covered with irregular ridges rising up to 14,000 feet elevation. From here the South Platte and Arkansas Rivers run east; the Rio Grande south; the tributaries of the Colorado River (the Green, White, Grand and San Juan Rivers) west; the North Platte river north.

The western third of the State is a high plateau, intersected by high, detached mountain ranges and peaks. Large parks are characteristic of this mountain section. In winter the snow at Durango, in the southwest, is said to be six feet deep. The rainfall west of the crest is much greater than east of the crest.

Forest fires have played more havoc in Colorado than in any other State.

3. Distribution: The central crest is sparingly timbered with yellow pine, lodgepole pine, limber white pine and foxtail pine. Engelmann's spruce, usually associated with balsam (lasiocarpa), yields the best logs and must be considered the main timber tree of Colorado. It is found at elevations ranging from 8,000 to 12,000 feet. On moist sites, forests are formed by Colorado blue spruce and the gray modest variety of Douglas fir, followed by quaking aspen after devastation. All over the foothills pinon dots the ground (edulis), often replaced by the one-seeded juniper. Along the rivers, a fringe of hardwoods (especially cottonwoods, box elder and ash) is found. The best timber is said to stand in the southwest. It seems that the western third of the State has some timber everywhere, although it is not heavily timbered anywhere. Lodgepole pine is the prevailing species in the parks. The Rocky Mountain oak (Quercus undulata) forms brushy thickets on all exposures. Rivers fringed with cottonwood, box elder, elm and ash.

4. Forest ownership: Most forest land belongs to the federal government. Lumbermen own 92,000 acres only. 44,000 acres of forest are said to be attached to farms. One-seventh of the wooded area is reserved.

5. Use: The forest is subservient to irrigation and mines. Majority of cut is yellow pine. Total cut in census year was 135,000,000 feet b. m., worth $1,627,000. Stumpage of yellow pine on best holdings 8,000 feet.

Logs on the stump are worth $1.12 per thousand; at mill, $4.99. There are 155 saw mills of $3,883 average investment, 59 of which are said to control 671,000 feet b. m. stumpage. Mineral products of the State are worth $30,000,000 annually. Stock pasture plays a very important part.

6. Forestry movement: Colorado's constitution is the only constitution emphasizing forestry. State forestry association since 1884. Various attempts to transfer custody of the United States forests, for protective purposes, to the State. Irrigationists strongly in favor of reserve policy.

7. Laws: In 1885 a State forest commissioner and "forest conservators" (justices of the peace and county commissioners) for the protection of forests. Fire law notices to be kept posted by the conservators. Law of 1897 creates a Department of Forestry, Fish and Game; its forest commissioner is charged with forest extension, with water preservation and with the care and records of all woodlands at any time belonging to the State.

The State agricultural college has four experiment stations and offers a course in arboriculture. A law of 1901 practically prohibits lumbering on public domain above irrigation districts. Campers must secure permits. Non-resident hunters must secure "game and forest wardens" for guides. Railroads are required to keep right of way cleared, to supply engines with spark arrestors, to be responsible for damage by fire started by locomotive sparks.

The Denver and Rio Grande has the privilege of obtaining repair material from United States forests.

8. Reservations: The reserves, in 1902, cover 4,849 square miles, which is 5% of area of State and 15% of wooded area They are well selected and should be increased in the southwest.

The South Platte forest reserve (683,520 acres), Plum Creek timberland reserve (179,200 acres) and Pike's Peak timberland reserve (184,320 acres), north of Colorado Springs, are extremely valuable for mines and irrigation purposes. They contain little merchantable timber, due to cutting and burning.

The Battlement Mesa forest reserve contains 858,240 acres; the White River forest reserve, 1,129,920 acres. These two reserves drain towards the Colorado River. The standing live timber of these two reserves, after Sudworth, consists of the following stumpage, in million feet b. m.:—

In White River reserve: Spruce, 930; balsam, 310; aspen, 100; lodgepole pine, 50; Douglas fir, 25.

In Battlement Mesa reserve: Spruce, 112; balsam, 37; aspen, 65.

9. Irrigation: The products of irrigation are forage crops and coarse grain staples; further, cantaloupes, peaches, potatoes.

Farming depends entirely on irrigation. On the South Platte and Arkansas Rivers irrigated farming is highly developed, handicapped in its progress by private ownership of water storage at the headwaters.

The irrigated area of Colorado, 1,611,000 acres, exceeds that of all other States. The value of the irrigated products was, in 1899, $15,100,000. The irrigation system constructed cost $11,700,000.

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## FORESTRY CONDITIONS OF CONNECTICUT:

1. Area under forest, 1,900 square miles, or 39% of the State, are classed as woodland.

2. Physiography: The Connecticut River traverses the State centrally, running north to south. Low mountains and hills stretching in the same direction show rugged and stony slopes.

3. Distribution: The primeval woods are extinct. A third or fourth growth of coppiced chestnut, oak, birch, ash, elm, hickory, basswood and cottonwood forms the woodlands, mixed with white pine said to readily reproduce on old fields and wood lots. The usual coppice rotation is 30 years.

4. Forest ownership: 50 mill firms own 9,195 acres of forest. Average stumpage is said to be 9,200 feet b. m. (?) 90% of the woodlands are attached to farms.

5. Use of timber: Stumpage costs $2.90; logs at mill, $7.88 per 1,000 feet b. m. 187 saw mills, mostly along the rivers, report an average investment of $3,567. The output of the lumber industry is rising in value.

| | |
|---|---|
| In 1860 | $ 572,000 |
| In 1880 | 1,076,000 |
| In 1900 | 1,118,000 |

The cut in 1900 aggregated 107,600,000 feet b. m., in which white pine participates with 23,800,000 feet b. m.; chestnut with 64,500,000 feet b. m. The coppice woods produce large quantities of fuel.

Leather industry: The output of 7 tanneries is valued at $891,000. It consumes 495 cords of hemlock bark, worth $3,810; 133 cords of oak bark, worth $1,041; 3,516 barrels of bark extract, worth $37,909; 205 bales of gambier; 494 barrels of quebracho; 111 tons of sumac, and chemicals worth $1,791.

In 1900, 50,000 hides and 300,000 sheep skins were tanned.

The output of the paper industry is valued at $3,565,000. No cord wood is used; only rags, waste paper, manilla, imported pulp and imported fiber.

6. Forestry movement: Some interest is manifested in planting waste sand land. The Connecticut forest association is presided over by the State forester.

7. Laws: Fire laws of 1886. Tax exemption on plantations made on abandoned fields, consisting of 1,200 saplings 6 feet high, for 20 years.

In 1901 the office of State forester (Mr. Walter Mulford) was created, charged with the acquisition of waste land at a price not to exceed $4 per acre. Appropriation, $2,000. Seed is to be used for planting. The expense of reforestation is not to exceed $2.50 per acre. The State pays taxes on her own woodland.

8. Reservations: None.

9. Irrigation: 56 farms, situated along brooks, have 471 acres under ditch; expense of system $34.21 per acre.

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## FORESTRY CONDITIONS OF DELAWARE:

1. Area: 700 square miles, or 35% of State, are wooded. Very little merchantable timber left after 12th census.

2. Physiography: Delaware occupies the northeastern portion of the peninsula formed by the Chesapeake and Delaware Bays. Soil sandy, slightly undulating.

3. Distribution: In the northern half of the State the broad-leafed species prevail. Here appears, scatteringly attached to farms, a struggling second growth of oaks, maple, poplar and

gum. In olden times "Delaware white oak," coming from this section, was famous as shipbuilding timber.

In the southern half of the State, woodlands consisting of pines (mitis; rigida; virginiana) and broad-leafed species predominate over the farms.

4. Forest ownership: 10 firms own 2,203 acres.

5. Use of timber: Logs on stump are worth $3.52; at mill, $5.55. 76 saw mills report an average investment of $3,255. The output of the mills rises in value from census to census, in spite of supplies reported as waning. It was in

| | |
|---|---|
| 1850 | $236,000 |
| 1880 | 411,000 |
| 1900 | 471,000 |

The cut in the census year consisted of:—

| | |
|---|---|
| Conifers | 30,000,000 feet b. m. |
| Hardwoods | 6,000,000 feet b. m. |

After Fernow, in 1887, 200,000 cords of firewood were cut, selling at $3 to $4 per cord. The Dupont Powder Works use willow charcoal, obtained from their own plantations. Staves and headings locally produced are worth $37,000. The local production of furniture and carriage stock, etc., is practically nill.

The leather industry is important, its output (from 20 firms) being $9,500,000 in the 12th census year. The product, however, consists almost entirely of goat skins. These skins are not tanned by the vegetable tanning process, but chemicals (chromium, aluminum and other salts) are used. The price of the chemicals consumed alone is $244,000. The consumption of hemlock bark amounts to 1,316 cords only; that of oak bark to 300 cords only.

The paper and pulp industry produces $600,000 worth of goods. It consumes large amounts of fiber and pulp produced elsewhere. There are used, however, 21,320 cords of poplar wood, locally produced and valued at $131,467 (for soda fiber).

6. Forestry movement: None.

7. Laws: Delaware has excellent laws relative to the main impediments to forestry, which are taxes and fires.

(1) Property is taxed only on its rental value. Hence woodland is almost exempt from taxation, the rents being exceedingly small.

(2) Firing of woodlands is punishable unconditionally and everywhere. The only fires allowed are those kindled between March 10 and May 1 by land owners intending to burn their clearings previous to plowing.

8. Reservations: None.

9. Irrigation: None.

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FORESTRY CONDITIONS OF FLORIDA:

1. Area: 37,700 square miles, or 70% of State's area, under forest, mostly stocked with commercial timber.

2. Physiography: Southern section consists largely of swamps and hummocks, impassable from June to October (Lake Okeechobee). North of the 28th degree of latitude, the country is level, rarely undulating. Here the swamps are found more near the coast.

The western section of the State, near Tallahassee, is higher than the rest (average about 250 feet above sea level), intercepted with low mountain ranges.

Frost is rare; the summer climate is unhealthy in the south. The Everglades show from 1 to 3 feet of water even during the dry season of the year. Drought frequent from February to June.

3. Distribution: Sargent estimates, in 1880, the stand of pine at 6,615,000,000 feet b. m. A line drawn from Charlotte Harbor to Cape Malabar divides the State into a northern three-fifths and a southern two-fifths.

(a) Northern section. It contains long leaf and Cuban pine, with some little Taeda. Long leaf pine, on its way south, loses continually in volume and in quality of timber. Along the shore, evergreen oaks, notably live oak, are found in place of pine; further, palmetto and scrub pines. In the western counties, near Tallahassee, broad-leafed species of northern character prevail besides the pines. Large yellow poplars, ashes and hickories occur here along the water courses.

In the bottoms, cypress and gum swamps are said to scale 10,000 feet b. m. per acre. Evergreen broad-leafed species (magnolias, oaks, bays) fringe such swamps. A species peculiar to this region is the "stinking cedar" (Tumion taxifolium) and the pencil cedar, the latter of splendid quality on hummocks and bottom land. Palmetto occurs everywhere on moist soil and abandoned fields as a weed. There is practically no echinata.

(b) Southern section. The southern section has only one pine, the Cuban pine, to show, which grows on sand dunes in the Everglades. Cypress swamps prevail everywhere. Along the coast and on the "Keys," the northern sentinels of the West Indian tropical flora occur in small specimens. Their occurrence is commercially unimportant. Amongst them are mahogany and lance wood (Ocotea catesbyana Sarg.).

4. Forest ownership: 113 lumber firms own 1,318,000 acres; balance of forests belong to State, federal government, farmers and holders of old Spanish land grants.

5. Use of timber: 368 saw mills of $16,588 average investment. Logs on stump worth $1.22, at mill $6.23. Value of mill output was in

| | |
|---|---|
| 1880 | $ 3,100,000 |
| 1890 | 5,500,000 |
| 1900 | 10,800,000 |

The cut in 1900 consisted of

| | |
|---|---|
| Cypress | 110,000,000 feet b. m. |
| Yellow pine | 712,000,000 feet b. m. |
| Hardwoods | 2,000,000 feet b. m. |

Red cedar (Virginiana) output is not given by the 12th census. The largest pencil cedar mills of the world exist at Cedar Keys. Cypress is used for door, sash, shingles, fish and syrup barrels; long leaf pine for railroad ties, car sills, trestle bridge timbers, doors, blinds, flooring and general house building purposes, also for shingles. Value f. o. b. steamer, on an average, now $14 per 1,000 feet b. m. (in 1895 only $9).

Conservative lumbering has been practiced along the Gulf coast by lumbermen for dozens of years, unknowingly, since only prime stumpage used to be convertible into lumber. Logging was done in former days by canals (which in many cases were 20 miles long), dug as connections between trees, swamps and water courses.

No leather industry, although the mangrove (Rhizophora mangle) forests of the tropical south might yield bark extremely rich in tannin.

No paper industry.

6. Forestry movement: None.

7. Laws: Wilful firing of woodlands punishable. Fires rare, after Sargent, owing to multitude of swamps.

8. Reservations: None.

9. Irrigation: Florida leads among the humid States—the rice-growing States excepted—in the value of irrigated products and in number of irrigated farms (only 1,485 acres). 180 truck farms (winter farming) report irrigation. Cost of system, $101.52 per acre (very high).

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## FORESTRY CONDITIONS OF GEORGIA:

1. Area under forest 42,000 square miles, or 71% of total area, containing, after 12th census, mostly (?) merchantable forests. Sargent, in 1880, estimated stand of pine at 16,800,000,000 feet b. m., a figure found much too low.

2. Physiography: The extreme northwestern eighth of the State is traversed by the Table Mountain and Alleghany Ranges, spurs of which protrude to Rome and Atlanta. Southeast of the mountains the Piedmont plateau occupies two-eighths of the State, separated by a line running through Augusta, Macon and Columbus from the remaining five-eighths of the State formed by the level or slightly undulating coastal plain. The huge Okefenokee Swamp lies in the extreme southeast.

3. Distribution: The mountainous section has the species of the southern Appalachians, namely, white, red, scarlet and chestnut oak; chestnut, walnut and hickory; yellow poplar, cucumber, sweet and yellow birch; cherry, beech, locust, rigid and table mountain pine; also white pine and hemlock. In the Piedmont plateau, oaks and hickories, with or under Pinus echinata (usually) or taeda. A stray island of long leaf pine is found on the Alabama line in the northwest. The lowlands of the coastal plain show long leaf pine on sandy soil, mixed with taeda on moister sites. Huge swamps near coast and rivers are stocked with cypress and gums. White cedar prefers the half-swamps. Evergreen broad-leafed species (Persea, Magnolia) line the swamps. Cuban pine grows far inland, up to 100 miles from shore, occupying the wet dells in the long leaf pine woods.

4. Forest ownership: 453 firms own 1,108,000 acres of forest, containing 3,800 feet b. m. average stumpage. The balance of the wood lands belongs to farmers, or to counties and State under tax-forfeitures.

5. Use of timber: Long leaf pine was and is frequently sold as "Georgia pine." The woods are far from being exhausted. The inroads of the turpentine industry seem more injurious to the perpetuity of the forest than those of the lumber industry. 1,202 mills of $4,274 average investment. Logs on stump are worth $1.01; at mill, $4.41. Logging by railroad and by rafting. Value of output in

| | |
|---|---|
| 1860 | $ 2,400,000 |
| 1870 | 4,000,000 |
| 1880 | 4,900,000 |
| 1890 | 6,500,000 |
| 1900 | 13,700,000 |

The cut of 1900 consisted of:—

| | |
|---|---|
| Yellow pine | 1,295,000,000 feet b.m. |
| Other conifers | 18,000,000 feet b. m. |
| Hardwoods | 39,000,000 feet b. m. |

Cooperage and miscellaneous industries are small, their output amounting to only $135,000 in the census year.

The leather industry produces in 36 establishments $1,187,000 worth of products and consumes 23,217 cords of oak bark (valued at $87,000); 85 cords of hemlock bark; 5,107 barrels of oak bark extract (worth $41,000), and 950 barrels of quebracho extract (worth $16,800).

Paper and pulp industry: None.

6. Forestry movement: In 1887 a bill asking for a forest commission, etc., seems to have failed.

7. Laws: Firing of woods by the owner must be preceded by notice given the adjoining land owners (excepting the months of March and April).

8. Reservations: None.

9. Irrigation: 7,856 acres of rice fields were irrigated in 1899, constituting 35% of the total rice area and yielding 72% of the total rice product. Cost of system, per acre, is $31.85.

## FOREST POLICY.

### FORESTRY CONDITIONS OF IDAHO:

1. Area: 35,000 square miles, or 42% of the State, are wooded.

2. Physiography: Southern third is traversed by the east and west course of the Snake River and consists of barren plains. The northern, wedge-shaped part of the State, contains the mountainous Coeur d'Alene region. The Teton and Yellowstone Ranges form the boundary towards Wyoming; the Bitter Root Mountains the boundary towards Montana. The mountains of central Idaho drain southward towards the Snake River, northward towards the Salmon River.

3. Distribution: Southern lava plains, destitute of timber and vegetation, except sage brush. The Salmon River Mountains are unexplored and contain, after Gannett, little timber. The Rockies show yellow pine, Douglas fir, lodgepole pine and western white pine. In the Bitter Root Mountains, Douglas fir and yellow pine prevail below 6,000 feet elevation, lodgepole pine above 6,000 feet elevation. In the extreme north a dense forest cover, originally found, is now badly burned. Here yellow pine and Douglas fir cease to be prevailing; white pine (monticola) and larch (Larix occidentalis) preponderate, numerically and in volume. In the Priest River Mountains three zones may be distinguished. In the highest zone, above 4,800 feet, balsam (Abies lasiocarpa) and white bark pine preponderate.

The zone between 2,400 feet and 4,800 feet is the largest and contains white pine and larch.

In the lowest zone, Douglas fir is mixed with yellow pine, lowland fir and western red cedar. Lodgepole pine is found all over the northern and eastern part of Idaho, taking advantage of heavy fires. Black hemlock, lowland fir and Engelmann's spruce also occur.

4. Forest ownership: 4,147,200 acres of forest land are reserved. Lumbermen own only 84,000 acres in the lowest zone, with 6,900 feet average stand per acre. Over 200,000 acres lie in the Indian reserves. Over 600,000 acres of forests are attached to farms.

5. Use: Timber is mostly used for mining props. The mill cut in 1900 was worth $937,000, and consisted largely of yellow pine. The stumpage is worth $1.09. Logs at mill are worth

$3.95. 114 saw mills report an average investment of $4,759. No paper, pulp or leather industries.

6. Forestry movement: Nill.

7. Laws: Usual fire and camper's laws. Arbor Day law.

8. Reservations: Bitter Root forest reserve, meant to protect irrigation in Washington, contains 4,147,200 acres, of which 690,000 acres lie in Montana.

The Priest River forest reserve, part of which (104,000 acres) lies in Washington, comprises 645,120 acres.

9. Irrigation: Only possible from small feeders in outskirt valleys.

The products of irrigation are forage crops (alfalfa) and small grain at the higher elevations of 4,000 to 5,000 feet; orchard fruit at elevations of 2,000 to 3,000 feet, notably along the lower course of the rivers (Snake River).

The irrigated area, 600,000 acres, has produced, in 1899, $5,400,000 worth of crops from irrigation systems costing $5,100,000.

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## FORESTRY CONDITIONS OF ILLINOIS:

1. Area: 10,200 square miles or 18% of area of State are classed as woodland.

2. Physiography: Gently rolling prairies. Mississippi River on western line. Illinois River traverses State from northeast to southwest.

3. Distribution: The southern third of the State once contained good to splendid hardwood forests stocked with the hardwoods of the Mississippi River Basin, in addition to cypress swamps. The northern two-thirds are prairie, excepting a belt along the lake, on which white pine is sparingly found. The oak openings on the prairie are stocked with burr, scarlet, red, black and post oaks.

4. Forest ownership: All woodland is attached to farms, excepting 162,000 acres of 4,800 feet b. m. average stumpage, owned by 167 lumber firms.

5. Use of timber: Chicago is still the most important lumber distributing center in the United States, fed by the pineries

of the Lake States and by the hardwood forests of the Mississippi Valley. There are found in the State 825 saw mills, of $3,815 average investment, and 280 large planing mills, of $25,000 average investment. The output of the lumber industry is rising, being $5,000,000 in 1880 and 1890, and $7,600,000 in 1900. The cut of home grown timber in 1900 consisted of:

| | |
|---|---|
| Conifers................ | 138,000,000 feet b. m. |
| Cottonwood............ | 19,000,000 feet b. m. |
| White oak.............. | 170,000,000 feet b. m. |
| Other hardwoods....... | 63,000,000 feet b. m. |

Logs are worth on stump $2.64 and at mill $8.36 per 1,000 feet b. m.

The leather industry has used in the census year 18,312 cords of hemlock bark (imported) and 22,846 bales of gambier. Products are valued at $7,800,000.

The pulp and paper industry uses only 864 cords of native wood, and depends on straw, rags, waste paper and pulp of foreign manufacture for its raw material.

6. Forestry movement: None except Arbor Day and bounties for prairie planting.

7. Laws: Firing of woods and prairies permissible only from April 15 to October 15. Railroads liable for fires starting from sparks. Bounty of $10 per acre for forest plantations.

8. Reservations: None.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF INDIANA:

1. Area: After 12th census, 10,800 square miles, or 30% of State, are wooded. No large forests exist.

After recent official investigations,

250,080 acres are stocked with heavy timber;
834,506 acres contain second growth, and
3,733,456 acres are described as thin wood pasture.

2. Physiography: Undulating land. Main river is the Wabash. 692,738 acres are classed as waste lands in 1903.

3. Distribution: Prairie only in some northern counties where the forest is said to be expanding. Entire balance of Indiana, 100 years ago, was heavily wooded with 12 species of oak, 3 of elm, 2 of walnut, 7 of hickory, 3 of maple, 3 of birch, 4 of ash, yellow poplar, linden, buckeye, black and honey locust, dogwood, catalpa, sassafras, hackberry, red mulberry, sycamore, ironwood, chestnut, beech, cottonwood, white pine, gray pine and Virginia pine, bald cypress, tamarack and red cedar. All trees show splendid bole development. The requirements of the farmer and home seeker have caused the forest to be considered a mere encumbrance of the ground. Only small groves now exist.

4. Forest ownership: 162 lumber firms, in 1900, owned 104,000 acres of woodlands. The rest is attached to farms.

5. Use of timber: Indiana leads the United States in the output of wagon stock (raw material), producing 33% of the entire output. In furniture stock, Indiana is second only to Ohio. One-half of Indiana's manufactures rely on the forest for their raw material. Log stumpage worth $5.39 (maximum amongst Union States); logs at mill worth $9.39 per 1,000 feet b. m. There are 1,829 saw mills of $4,500 average investment.

Output of the lumber industry

| | |
|---|---|
| In 1870 was | $12,300,000 |
| In 1880 was | 14,300,000 |
| In 1890 was | 20,800,000 |
| In 1900 was | 20,600,000 |

The cut in 1900 was:—

| | |
|---|---|
| Conifers | 3,000,000 feet b. m. |
| White oak | 646,000,000 feet b. m. |
| Other hardwoods | 336,000,000 feet b. m. |
| Total | 985,000,000 feet b. m. |

The leather industry, comparatively small, produces $1,500,000 of leather and consumes 700 cords of hemlock bark, 7,000 cords of chestnut oak bark and 5,000 barrels of oak bark extract.

The pulp and paper industries are said to use 6,300 cords of domestic (?) spruce, 10,500 cords of Canadian spruce, 20,300 cords of poplar and 4,200 cords of miscellaneous woods, in addition to a large quantity of rags and straw (120,000 tons). 39 mills produce $4,200,000 of paper products.

6. Forestry movement: Recent, but energetic propaganda, influenced by John P. Brown (of Connersville).

State forest association.

7. Laws: Fire laws since 1818. A unique forest reservation law (of 1899) encourages private reserves. Such reserves (which must not exceed in acreage an eighth of a tract individually owned, trees per acre) are assessed at $1 per acre only, whilst the average assessed value of farm land, in 1898, was $20. In 1901 there existed 284 private reserves, covering 5,312 acres. Law of 1901 creates a Board of Forestry, consisting of five members, one of them drawing a salary (W. H. Freeman). Its duties are:—

(1) Collection of statistics.

(2) Forestry education.

(3) Formulation of plans for private and State forest reserves. Insufficient appropriations.

8. Reservations: 2,000 acres of State forest reserves are set aside by law of 1903, as a demonstration forest and for nursery purposes.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF IOWA:

1. Area: Area of woodlands is 7,000 square miles, equal to 13% of area of State. Settlement has reduced the woodland area by 50%. Planted forests said to aggregate 120,000 acres.

2. Physiography: Level or undulating land, extending from the Missouri to the Mississippi.

3. Distribution: Broad bottom lands of the Mississippi bore, and still bear splendid hardwoods, the best in the southeastern section. In the western prairie section the streams are skirted with hardwood groves from one-half to 4 miles wide. Of the northeastern flora there occur in the hardwood bottoms: shag bark and bitternut hickory; burr, red, black and white oaks; green ash, hard and soft maple, box elder, basswood, white

elm and butternut. From the southeast enter the Kentucky coffee tree, honey locust, swamp white oak, pin oak, laurel oak, red bud, Ohio buckeye, mocker nut, pecan and black walnut. The only conifers found are white pine, scattered in extreme northeast, and red cedar.

4. Forest ownership: Practically all woodland belongs to farmers. 43 lumber firms own 56,160 acres, stocked with 4,900 feet b. m. on the average acre.

5. Use of timber: Woodlands are used for pasture. During seasons of drought, young growth is frequently found dying. The lumber industry, in addition to the cooperage industry, is about to exhaust the fine hardwoods. Logs on stump are worth $4.95; logs at mill, $12.16 (maximum of the United States). Still there are now left 264 mills of $18,885 average investment. The largest of these mills are located on the Mississippi River, and saw pine rafts coming from Minnesota and Wisconsin.

The value of the sawn product in 1870 and 1880 was $6,000,000; in 1890 it was $12,000,000; in 1900 it had dropped to $8,700,000.

The output of the mills in the census year was 303,000,000 feet b. m. of conifers and 40,000,000 feet b. m. of hardwoods. Since there is but little white pine found in Iowa, it seems as if white pine, not home grown, composed the bulk of the output of softwoods. Lumbermen, however, are said to still own, inside the State, 231,000,000 feet b. m. of conifers (?).

Leather industry, none. Paper industry uses straw (12,350 tons of straw in census year).

6. Forestry movement: Arbor Day since 1874. Prairie planting still practiced, the favorite species being soft maple, green ash and box elder. The Agricultural College at Ames has given instruction in tree planting for almost 30 years.

7. Laws: Prairie fire law. A law exempting almost $6,000,000 worth of property from taxation, in order to encourage tree planting, is now repealed.

8. Reservations: None.

9. Irrigation: No data available.

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## FORESTRY CONDITIONS OF KANSAS:

1. Area: 5,700 square miles, or 7% of the State's area, are wooded.

2. Physiography: Undulating prairies. Arkansas River, from Colorado, traverses the western half.

3. Distribution: A few yellow pines occur in the higher ridges of the western section, which is otherwise treeless, except for the fringes of poplar and willow in the river canyons.

The eastern section shows wide belts of hardwood forests along the streams, the best timber being found in the extreme southeast, where the heavy timbered outskirts of the Mississippi River hardwood bottom lands appear.

4. Forest ownership: About 1,000,000 acres of forest are said to be attached to farms. Not quite 8,000 acres are owned by 22 lumber firms, stocked with 3,500 feet b. m. on the average acre.

5. Use of timber: Lumber industry in Kansas has declined since 1880, when 146 establishments were cutting 45,000,000 feet b m. of lumber.

In 1900 there were in existence 54 mills, showing lowest average investment in the United States, namely, $1,070. Value of product, $104,000, against $683,000 in 1880. Log stumpage worth $2.17; logs at mill, $7.84 per 1,000 feet b. m.

Fuel and fencing are badly required by the farmers.

Lumber for building purposes obtained from the east and south.

Paper, pulp and leather industries: None.

6. Forestry movement: Usual Arbor Day enthusiasm.

The State Agricultural Board reports 119,000 acres planted in forest since 1884.

Some of the best catalpa plantations are found on rich prairie soil in Kansas. In 1885 the office of Commissioner of Forestry was created, issuing reports and distributing seedlings. The State Horticultural Society tries to centralize interest in tree planting and issues a Tree Planter's Manual. Kansas City boasts of employing a "Forester."

7. Laws: Bounty Law of 1868 is repealed. Wilful firing is fined $500. It is the sworn duty of the justices of the peace to bring incendiaries to judgment.

8. Reservations: 94,732 acres of sandy land, south of Arkansas River, are withdrawn from entry to be used for planting trees. No presidential proclamation issued so far.

9. Irrigation: In the census year 24,000 acres of land were irrigated (2,000 acres from wells).

The irrigated crop was valued at $226,000. The construction expense of the irrigation system was $530,000.

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FORESTRY CONDITIONS OF KENTUCKY:

1. Area: Area of woodlands 22,000 square miles, or 53%.

2. Physiography: Ohio River on the north. Mississippi River on the west. The Big Sandy, tributary of the Ohio River, on West Virginia line. Cumberland Mountains in the extreme southeast, giving rise to the Kentucky River, which runs north into Ohio, and to the Cumberland River. Undulating plateau well watered.

The Cumberland Mountains, where limestone formation prevails, have coal and iron mines. Middlesborough about the center of the coal industry.

3. Distribution: Kentucky "barrens" in the southwest, very productive of tobacco, hemp and grain. Here the pioneers found big stumps called "stool grubs," the remnants of a splendid forest, probably burned by the Indians. The black oak forest (black jack, black post and Spanish oak) is gradually invading the "barrens."

The bottoms of the Ohio and Mississippi Rivers, subject to inundations, exhibit in the swamps bald cypress, sweet and black gum. On very wet soil, cottonwoods, cow oaks, gums, ashes and hickories of splendid development occur. On somewhat drier soil, beech, red oak, yellow poplar, white oak and burr oak prevail.

In the "Blue Grass Region," gigantic red cedars, walnuts, poplars, hickories, beeches, sycamores, lindens, locusts, coffee trees and white oaks have been cleared away, and only groves or fringes of these species are now left. In the mountain section, walnuts, chestnuts, chestnut oaks, yellow poplars, ashes, hickories, three maples, locusts, white, red and black oaks of splendid development form the bulk of the timber.

The section above the falls of the Cumberland River was practically untouched as late as 1880.

The pines form only a small percentage of the timber. White pine, accompanied by hemlock, occurs at the higher altitudes of the Cumberland Mountains. Echinata is scattered over the southern two-thirds of the State, especially in the east, never forming pure forests, groves on abandoned fields excepted. Pinus Virginiana seems to develop unusually good boles in the eastern half of State and is locally used for custom lumber. Rigida is found, like echinata, running up higher into the mountains.

4. Forest ownership: 208 mill firms own 382,000 acres of forest, having 4,700 feet b. m. average stumpage. After the 12th census this stumpage includes 125,500,000 feet b. m. black walnut, which figure seems largely overestimated.

5. Use of timber: The value of the sawn product was in

| | |
|---|---|
| 1850 | $ 1,500,000 |
| 1860 | 2,500,000 |
| 1870 | 3,600,000 |
| 1880 | 4,100,000 |
| 1890 | 7,900,000 |
| 1900 | 13,800,000 |

The cut in 1900 consisted of:—

| | |
|---|---|
| Conifers | 34,600,000 feet b. m. |
| Ash | 4,900,000 feet b. m. |
| Black walnut | 2,100,000 feet b. m. |
| Poplar | 279,000,000 feet b. m. |
| White oak | 392,800,000 feet b. m. |
| Other hardwoods | 63,100,000 feet b. m. |
| Total | 776,500,000 feet b. m. |

In the census year there were further produced 60,000,000 shingles, worth $115,000; 63,000,000 (mostly) oak staves, worth $1,042,000; 3,500,000 sets of heading worth $234,000. Furniture, wagon and agricultural stock is valued at $1,358,000. Kentucky ranks 6th in cooperage and 8th in miscellaneous timber industries. The ratio of forestry in wages, investments and products to all other industries, in 1900, was that of 14 to 100. 1,232 mills showed an average investment of $4,658. Logs are worth on stump $2.67, and $6.86 at mill. Logging in mountains by oxen; elsewhere by oxen, horses and mules. Transportation largely by raft, or loose driving. Small portable mills in tracts far from rivers and railroads. Big mills on Cumberland River.

Leather industry yields, in 1900, a product worth $3,750,000, and uses 1,080 cords of hemlock bark, worth $9,440; 29,840 cords of oak bark, worth $22,400; 13,300 barrels of bark extract, worth $139,000; besides some quebracho, gambier and sumac.

Paper and pulp industry is insignificant.

6. Forestry movement: Little; recently stirred up by Federation of Women's Clubs. Berea College gives, through Prof. S. C. Mason, excellent training in conservative forestry to farm boys. Agricultural reports allude to forestry and its importance.

7. Laws: In a number of counties the firing of woods is forbidden. Constables are required to extinguish fires at expense of county.

8. Reservations: None.

9. Irrigation: None.

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FORESTRY CONDITIONS OF LOUISIANA:

1. Area: 28,300 square miles, or 62% of the total area of the State, are wooded.

2. Physiography: Undulating land, alluvial soil, river bottom lands subject to continuous inundations. Mississippi River forms the eastern line. Red River of the South traverses the State from northwest to southeast. Sabine River is on the Texas line; the Pearl River on the lower Mississippi State line. A multitude of water-courses form a help to the utilization of the forest and to the prevention of fires.

3. Distribution: After the 12th census, the southwest portion is prairie. Long leaf pine in two large bodies, separated by the Red River, aggregating 4,300,000 acres of densest stumpage (4,000 to 6,000 feet and over per acre) often untouched. No Cuban pine. Echinata and Taeda extend from Red River northward to State line. The former species frequently shows an undergrowth of Spanish oak, black jack, post oak and hickories. Cypress grows in enormous swamps, with red gum and black gum. Along rich bottoms, evergreen magnolias, water oaks, red oaks, gums, cottonwoods, burr oak, white ash, pecan, persimmon, sassafras and beech. In drier localities, cow oak and burr oak.

## FOREST POLICY.

4. Forest ownership: The State owns large swamp tracts. The farmers own 35% of all the woodlands. 170 lumber firms own 1,500,000 acres of 6,700 feet average stumpage.

5. Use of timber: The use of cypress for cooperage was large as early as 1880, when the pine woods were still untouched. The main center of long leaf pine mills is now at Lake Charles (Calcasieu River). Main center of short leaf pine mills is at Shreveport (Red River).

In 1900, 405 mills existed, of $25,800 average investment. Logs were worth, in 1900, on stump, $1.22, and at mill, $5.59.

New Orleans is not a mill center, but is the largest southern shipping point of the lumber and cooperage industry.

Moss ginning is an industry turning out, in 1880, $550,000 worth of material. There are no later statistics. Turpentining is only recently introduced, tending to ruin the prospects for conservative lumbering, owing to the danger of fire connected with it. In 1880, Sargent's fire statistics show a loss of $6,000 worth of timber only, virgin pine being fireproof and the other species protected by swamps. Sargent, in 1880, estimates the stand of pine at 48,200,000,000 feet b. m. The products of the lumber industry are valued, in 1880, at $1,700,000; in 1890, at $5,700,000, and, in 1900, at $17,400,000; a very rapid increase.

The cut in 1900 consisted of 1,200,000,000 feet b. m. (800,000,000 yellow pine, 340,000,000 cypress, 50,000,000 cottonwoods, 5,000,000 white oak). The average stand of white oak is said to be 7,800 feet b. m. per acre (?). Swamps cleared of cypress are doomed to lie barren.

No pulp industry.

Three small leather concerns use a few cords of oak bark, sumac and a few barrels of extract.

6. Forestry movement: None.

7. Laws: Unknown.

8. Reservations: None.

9. Irrigation: Louisiana, leading the States of the Union in rice production, irrigates from water-courses and from wells 202,000 acres of rice fields.

The cost of the irrigation system averages only $12.54 per acre.

## FOREST POLICY.

### FORESTRY CONDITIONS OF MAINE:

1. Area: Woodlands comprise, after 12th census, 23,700 square miles, or 79% of State. In 1893 the State assessor reports only 15,000 square miles of forest.

After report of the forest commissioner in 1903 forest lands comprise 21,000 square miles, and 14,800 square miles are taxed as "wholly wild land."

2. Physiography: The north and northwest are said to be mountainous. Mount Katahdin, the highest peak, is 5,385 feet high. The south and southeast is hilly. Lakes, valuable for forest transportation, are found all over the State. The coast line is deeply indented. The most important rivers are the Androscoggin, Kennebec, Penobscot and St. John, the latter on and close to the New Brunswick line. 18,000 square miles are absolute forest land.

3. Distribution: The conifers of the northern pine belt (white pine, red spruce, white spruce, hemlock, balsam, tamarack, white cedar) occur mixed with maple, white and yellow birch, beech, ash, oak, hickory and basswood in varying proportions. Large bodies of hemlock used to exist in the southeast. Valuable bodies of poplar are found, especially on the Kennebec. Only the immediate coast region between the Kennebec and Penobscot lacked the conifers.

The State is largely cleared in the south, and the north is culled of its white pine. Pulp wood has been removed from one-half of the wild lands. Still lumbermen alone in 1900 were reported to be owners of over 1,000,000,000 feet b. m. of white pine. Good second growth of white pine is found all over the southern counties. Regeneration of spruce is frequently met beneath an ushergrowth of gray and white birch, poplar and pine.

The sustainable yield of the spruce woods amounts to 637,000,000 feet b. m. (after Ralph S. Hosmer) per annum.

Forest Commissioner E. E. Ring publishes the following figures as the result of recent explorations:—

Stumpage of coniferous timber (9 inches and over in diameter) in million feet b. m.

| Drainage System. | St. John River. | Penobscot River. | Kennebec River. | Androscoggin River. | Ten Minor Rivers. |
|---|---|---|---|---|---|
| Spruce...... | 6.942 | 5,166 | 3,883 | 3,248 | 2,000 |
| Pine ........ | 427 | 153 | .... | .... | .... |
| Cedar ....... | 1,830 | 438 | .... | .... | .... |

4. Forest ownership: 204 saw-mill firms own 2,108,000 acres of 2,000 feet (only?) stumpage. Paper firms own several hundred thousand acres of woodland, largely cut over. 22.4% of woodland is attached to farms.

5. Use of timber: The State contains 832 saw mills, of $11,754 average investment. Stumpage costs $2.52; logs at mill, $8.15 per 1,000 feet b. m.

Value of output of saw mills and timber camps was:—

| | |
|---|---|
| 1850 | $ 5,900,000 |
| 1860 | 6,600,000 |
| 1870 | 11,400,000 |
| 1880 | 7,900,000 |
| 1890 | 11,800,000 |
| 1900 | 13,500,000 |

The cut for saw mills in 1900 consisted of:—

| | |
|---|---|
| Spruce | 425,000,000 feet b. m. |
| White pine | 220,000,000 feet b. m. |
| Hemlock | 89,000,000 feet b. m. |
| Other conifers | 87,000,000 feet b. m. |
| Hardwoods | 29,000,000 feet b. m. |
| Total | 850,000,000 feet b. m. |

There were produced in the census year $903,000 worth of shingles, $408,000 worth of cooperage stock, $364,000 worth of lath, $600,000 worth of boxes, $20,000 worth of baskets and woodenware, $294,000 (60% of output of United States) worth of bobbins and spools (white birch) (Ring reports a production of 800,000,000 spools, worth $1,000,000, for 1903).

The hardwood industries are increasing with the expansion of the railroads ("Hardwood Novelty Mills"). Modern lumbering is astonishingly conservative and never destroys the chances of a good second growth. Conservative lumbering in pure spruce woods ("black growth") is, however, apt to be followed by sweeping blow-downs. Logging for pulp, consuming about 275,000,000 feet b. m. annually, is less wasteful than logging for lumber. Saw mills, on the other hand, are less interested in permanent supplies than pulp mills. Average age of spruce logs is about 200 years. The use of the cross-cut saw is novel in the Maine woods. Logs are usually peeled (which requires summer cutting), and long lengths of logs are held out. Railroading is gradually superceding river driving.

Leather industry: 31 firms produce $2,451,000 worth of leather and consume 40,600 cords of hemlock bark, worth $229,000; 4,000 cords of oak bark, worth $28,000; 1,080 bales of gambier, worth $7,370; 200 barrels of extract, worth $2,740; 125 tons of sumac, worth $7,675; chemicals, worth $5,615.

Paper and pulp industry: 35 mills produce in the census year $13,200,000 worth of material and consume: home-grown spruce, 265,000 cords, worth $1,325,000; Canadian spruce, 20,600 cords, worth $170,000; home-grown poplar, 49,000 cords, worth $199,000; Canadian poplar, 500 cords, worth $1,700; other pulpwood, 6,500 cords, worth $21,700.

6. Forestry movement: Public sentiment is aware of the inter-dependence between the State's prosperity and the safety of the forest; hence forest fires are not allowed to roam at random. The memory of famous fires, like the Miramichi fire of 1825, has helped to mould public opinion. The fire warden system, however, is still inadequate.

The public are interested in developing the resort character of the woods. Pine offspring in farming sections is carefully husbanded.

Good reports by Chas. E. Oak and Austin Cary in 1894 and 1896; by E. E. Ring in 1902.

7. Laws: The State Land Agent (now E. E. Ring) acts as Forest Commissioner, since 1891. His duties are:—

(1) Forestry education, through public schools.

(2) Preparation of circulars relative to care of woodlands, to be furnished upon application to any citizen of the State.

(3) Distribution of fire reports (blank forms) amongst fire wardens.

(4) Posting fire law notices.

(5) Collecting forest, lumber and fire statistics.

(6) Prevention, control and extinguishment of forest fires in unorganized townships.

Guides are licensed and charged with protection of the forest.

Fire wardens are

(a) In unorganized townships appointed by the forest commissioner (since 1903), paid by the State at the rate of $2 per day. Helpers summoned by the warden are paid 15c. per hour. An emergency fund of $10,000 annually is set aside for this purpose by the legislature.

(b) In organized towns recruited from the selectmen, each selectman serving ex officio as warden for a specified district, at the expense of the town, which also pays for helper's services.

The fire wardens shall submit to the forest commissioner reports on the extent, damage and cause of forest fires; further, on the remedial measures taken to subdue fires within their wardships.

Fire wardens seem, however, not punishable for neglect of duty.

The forest commissioner has, unfortunately, no control over the fire wardens in organized towns.

8. Reservations: None.

9. Irrigation: 11 farms irrigate 17 acres for truck production.

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## FORESTRY CONDITIONS OF MARYLAND:

1. Area: 4,400 square miles, or 44% of State. After 12th census very little of wooded area contains merchantable timber.

2. Physiography: Three sections.

Western section in Alleghanies and Blue Ridge Mountains, with altitudes of over 3,000 feet. The Potomac, forming the West Virginia and Virginia line, breaks through the Blue Ridge on extreme east corner of West Virginia.

The middle section presents a plateau, falling from the Blue Ridge down to Chesapeake Bay.

The eastern section of lowlands consists of two peninsulas formed by the Chesapeake Bay, Potomac River and Delaware Bay.

3. Distribution: The mountain section was, originally, heavily timbered with white pine, hemlock, maple, birch, beech and spruce—the Adirondack forest at an elevation 1,000 feet higher than it is found in the Adirondacks. Now little virgin forest is said to be left.

The central section was, originally, covered with hardwoods. Now chestnut coppice prevails, or a second growth of white oak, black oak, hickories and gum.

The eastern peninsula shows a second or third growth of pitch and scrub pine, mixed with hardwoods.

4. Forest ownership: 114 firms own 66,928 acres of 3,700 feet b. m. average stumpage.

5. Use of timber: The lumber manufacture has never been prominent in Maryland. After the census reports, however, it continues growing, in spite of the lack of primeval supplies. The output of the Maryland mills was valued in

| | |
|---|---|
| 1850 | $ 585,000 |
| 1860 | 605,000 |
| 1870 | 1,501,000 |
| 1880 | 1,813,000 |
| 1890 | 1,600,000 |
| 1900 | 2,650,000 |

The cut in 1900 consisted of:—

| | |
|---|---|
| Yellow pine | 79,000,000 feet b. m. |
| Hemlock | 21,200,000 feet b. m. |
| White pine | 1,600,000 feet b. m. |
| Spruce | 3,500,000 feet b. m. |
| Miscellaneous conifers | 4,300,000 feet b. m. |
| Oak | 66,000,000 feet b. m. |
| Chestnut | 5,000,000 feet b. m. |
| Poplar | 5,000,000 feet b. m. |
| Miscel. hardwoods | 2,300,000 feet b. m. |

Logs on stump are worth $2.92; at mill, $6.75. 366 mills represent an average investment of $3,643.

The cooperage industry was important in olden times; had greatly declined in 1880, and depends in 1900 almost entirely on the use of imported cooperage stock, turning out $700,000 worth of products. The home grown staves and headings are worth only $15,000. No furniture stock and little carriage stock is obtained inland.

The box factories turned out, in 1900, $1,800,000 worth of boxes, and seem to depend on imported stock for raw material.

Leather industry: There are 21 tanneries of $1,754,000 annual output. They consume 3,116 cords of hemlock bark, valued at $21,888; 12,087 cords of oak bark, valued at $80,603; 309 barrels of oak bark extract; 111 tons of sumac and chemicals; 25 tons of quebracho.

The paper and pulp industry produces, in 21 mills, $2,600,000 worth of products and uses 23,229 cords of home-grown spruce, worth $147,615; 4,616 cords of poplar, worth $30,825; 20,623 cords of other woods, worth $135,825.

6. Forestry movement: None.

7. Laws: A bill, failing in 1902, provided for:—

(a) State Board of Forestry, consisting of three members, one to be a scientific forester, two to be owners of 100 acres of farm land. Commissioners hold office at Annapolis, are supplied with a secretary and receive $600 each annually. Their duty is to purchase woodland at the headwaters, at a price not to exceed $8 per acre, or else deforested land in other sections of the State. No price limit is given for the latter purchases. An appropriation of $30,000 annually is set aside for land purchase, and $6,000 for salaries and expenses.

(b) Bounties of 10 cents a tree shall be paid for every locust, black walnut, hickory, red and black oak planted according to certain regulations; also a bounty of 5 cents for every chestnut thus planted and for trees of other species fit for fence posts. $5,000 are annually provided for bounty payments.

Only malicious firing is punishable.

8. Reservations: None, the above cited reserve law having failed to pass.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF MASSACHUSETTS:

1. Area under forest: After 12th census, 4,200 square miles, or 52% of the State, are wooded. A State canvass of 1885 gives, however, only 1,390,000 acres of woodland classed as follows:—

317,000 acres of timber over 30 years old.
993,000 acres of growth under 30 years old.
6,000 acres of planted forest,
74,000 acres of woodland not classified.

2. Physiography: The western half of the State is mountainous. Here the Taconic and Hoosac Ranges, with the Berkshire Hills, rising in Mount Graylock to 3,535 feet elevation. The eastern half is hilly, or flat in the southeastern peninsula.

3. Distribution: Massachusetts forms part of the northern pine belt, stocked originally with white pine, hemlock and spruce, mixed with hardwoods in varying proportions. The hard-

wood coppice now existing consists of maple, chestnut, oaks, gray birches, hickories and pitch pine. Scattering red cedar and a few groves of white pine or hemlock are frequently met.

4. Forest ownership: The Boston park system now aggregates 6,784 acres. 162 lumber firms own 41,000 acres of 9,000 feet b. m. stumpage. Cities near South Orleans, after Sargent, have fully 10,000 acres planted in pitch pine. The balance of the woodlands is attached to farms.

5. Use of timber: Stumpage costs $2.64; logs at mill, $9.49. 534 saw mills, the larger ones placed along the Connecticut, report an average investment of $7,518. The value of the sawed output is constantly rising:—

| | |
|---|---|
| 1850 | $1,500,000 |
| 1860 | 2,200,000 |
| 1870 | 3,500,000 |
| 1880 | 3,100,000 |
| 1890 | 5,200,000 |
| 1900 | 6,500,000 |

The cut of the mills in 1900 consisted of:—

| | |
|---|---|
| Spruce | 29,000,000 feet b. m. |
| White pine | 261,000,000 feet b. m. |
| Hemlock | 12,000,000 feet b. m. |
| Other conifers | 2,000,000 feet b. m. |
| Chestnut and oak | 42,000,000 feet b. m. |
| Total | 346,000,000 feet b. m. |

A large proportion of this cut seems, however, to have originated in Vermont and New Hampshire.

Farm lots are said to produce nearly 600,000 cords fire wood and over 400,000 railroad ties.

Woodenware, manufactured from second growth white pine, forms an important industry (notably near Winchendon).

Large production of hoop poles. The miscellaneous industries are otherwise insignificant. The box, casket and barrel industries rely entirely on stock imported from other States for a production valued at $5,500,000 per annum.

Leather industry: Massachusetts is second only to Pennsylvania in leather production. 119 plants produce $26,000,000 worth of leather and consume 62,000 cords of hemlock bark, worth

$498,000; 1,000 cords of oak bark, worth $9,000; 15,500 bales of gambier, worth $106,000; 17,000 barrels of extract, worth $170,000; 3,600 tons (!) of sumac, worth $190,000; 500 tons quebracho, worth $8,000; chemicals worth $307,000.

Paper and pulp industry: Massachusetts is second only to New York in these industries; still her consumption of wood is small, consisting of home-grown spruce, 21,200 cords, worth $110,-000; Canadian spruce, 13,800 cords, worth $113,000; home-grown poplar, 3,000 cords, worth $18,000; other wood, 1,000 cords, worth $5,000. Enormous amounts of rags, manilla, waste paper; further, imported pulp and fiber form the chief raw material.

6. Forestry movement: The Massachusetts Forestry Association is backed by wealthy and educated tree lovers, and employs a forester (T. F. Borst). The Arnold Arboretum, at Jamaica Plains, offers unrivalled advantages to the student of dendrology. Chair of forestry at Harvard since 1903.

7. Laws: The selectmen of towns appoint annually one or more fire wardens, paid according to the pleasure of the town. Unique and interesting is a law allowing cities and towns to contract loans and to secure State contributions (50% of expense) for forest park purposes. Tax exemptions are granted for ten years on plantations, consisting of 2,000 saplings over 4 feet high (per acre), made on abandoned fields. Sand dunes at Cape Cod are being replanted under State law.

8. Reservations: City reserves are small, but of great local importance. Three State reserves, called the Mount Tom, Graylock and Wachusett State Parks, were established in 1902 and placed in charge of a State forester.

9. Irrigation: 28 farms irrigate 134 acres, for truck production.

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## FORESTRY CONDITIONS OF MICHIGAN:

1. Area: Area of woodland, inclusive of stump land, is 67% per cent of State area, or 38,000 square miles. Fernow gives 38% only.

2. Physiography: Two peninsulas. Ground level or undulating with sandy or gravelly ridges. Splendid shipping facilities via the lakes. Rivers important in the white pine industry are the Muskegon, Manistee, Shiawassee, Kalamazoo and Saginaw.

3. Distribution: Prairies only in the extreme south of the lower peninsula. South of the 43d degree of latitude, broad-leaved species prevail on land pre-eminently fit for agriculture. Here are found elm, ash, basswood, maple and white oak of splendid development.

The northern part of the lower peninsula and the entire upper peninsula were occupied by the famous pineries of Michigan, sprinkled with swamps of tamarack, cedar, spruce and balsam, and sand barrens stocked with jack pine, poplar, birch and scrub oak.

In the pineries there are mixed with the white pine, often as an undergrowth, ash, sugar maple, beech, oaks, hemlock, basswood, elm.

In 1880 the standing hemlock was estimated to be seven billion feet b. m., carrying seven million cords of bark.

The maple sugar industry is important, Michigan ranking third in 1880.

4. Forest ownership: The State claims 3,000,000 acres of so-called tax homesteads, which are held for sale to ignorant immigrants.

320 lumber firms own 2,750,000 acres stocked with 5,300 feet b. m., on an average.

In the southern section wood lots are usually owned by farmers.

5. Use of timber: From 1862 to 1887 the State produced $870,000,000 worth of white pine. In 1880, Sargent reports for white pine a growing stock of 35,000,000 feet b. m., whilst Fernow, in 1896, estimates it at 6,000,000 feet b. m. (underestimate). Another five years will, probably, bring about the end of the white pine in Michigan.

In lumber production Michigan has recently lost its leadership, held since 1870, to Wisconsin. The value of the saw mill products was in

| | |
|---|---|
| 1850 | $ 2,500,000 |
| 1860 | 7,000,000 |
| 1870 | 32,000,000 |
| 1880 | 52,000,000 |
| 1890 | 83,000,000 |
| 1900 | 54,000,000 |

The cut of 1900 consisted of:—

| | |
|---|---|
| White pine ........ | 1,300,000,000 feet b. m. |
| Hemlock ........... | 850,000,000 feet b. m. |
| Cedar ............. | 370,000,000 feet b. m. |
| Other conifers ..... | 110,000,000 feet b. m. |
| Ash ............... | 86,000,000 feet b. m. |
| Basswood .......... | 46,000,000 feet b. m. |
| Elm ............... | 110,000,000 feet b. m. |
| Maple ............. | 400,000,000 feet b. m. |
| White oak ......... | 135,000,000 feet b. m. |
| Other hardwoods... | 52,000,000 feet b. m. |

Logs are worth on the stump $3.06; at mill, $7.60.

1,613 mills of $20,900 average investment are reported. Michigan still leads the United States in the value of miscellaneous forest products (furniture, wagon, agricultural, cooperage and flooring stock), the output being $6,700,000.

In the shingle production, worth $3,200,000, it is second only to Washington. The splendid railroad systems developed in the past now facilitate the logging of hardwoods. A State census of 1884 estimates the cord wood consumption at 5½ million cords annually, worth 8.9 million dollars.

Paper industry uses 12,300 cords of home-grown spruce and 83,000 cords of Canadian spruce. Total value of product is $4,200,000, for 1900.

Leather industry consumes in census year, in 27 tanneries, 62,000 cords of hemlock bark, valued at $498,000; 1,000 cords of oak bark, valued at $8,800; 3,700 barrels of hemlock bark extract, worth $45,000, and 13,500 barrels of oak bark extract, worth $124,000.

6. Forestry movement: The impediments to conservative forestry are: Agricultural qualities of white pine soil, excessive taxation, total lack of means to check fires, difficulty of conservative lumbering in scattering holdings of virgin woods subject to wind fall.

In 1875 a forestry commission was created, dying after two years of existence.

In 1887 the State Board of Agriculture was constituted as a "Forestry Commission." Forestal agitation is lead by Senator C. W. Garfield, assisted by the university, the agricultural college, farmers' institutes and women's clubs.

In 1899 the "Forestry Commission" (appropriation $2,000 annually) was revived as a commission of inquiry and legislative advice. It consists of three scientific members, but no lumbermen. Allowance $2,000 a year, to be spent for gathering statistics. A department of forestry was established in 1901 at the State University (now under Dr. F. Roth), and 57,000 acres of land forfeited for non-payment of taxes were turned over to the commission to be worked for two years. In lieu of these 57,000 acres a recent law has turned over to the commission all State holdings in three townships at the head waters of the Muskegon River. By the aid of a continuous appropriation of $7,500 a year, the commission is gradually acquiring the contiguous lands, so as to make these reserve holdings more solid. The attempt of reserving all land forfeited for non-payment of taxes (and of a protective character) for State reserves failed in 1901.

7. Laws: Fire laws since 1817. Not enforced. Loss from fires reported by Sargent is $1,000,000 in 1880.

8. Reservations: Now 64,000 acres at the head of the Muskegon River.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF MINNESOTA:

1. Area: Woodlands, inclusive of stump land, cover 52,000 square miles, an area equal to 66% of the State. Stand of white pine after Sargent, in 1880, eight billion feet b. m.; after Gen. C. C. Andrews, in 1895, seventeen billion feet b. m.; after Horace B. Ayres, in 1900, twelve billion feet b. m.

2. Physiography: Undulating. 10,000 lakes and lakelets, the largest being Red Lake, Leech Lake and Millelac Lake. A multitude of swamps increase in size and number towards the north. Hills are rare. The Rainy River and Rainy Lake form the boundary line towards Ontario; the St. Louis River empties at Duluth; the St. Croix River runs on the Wisconsin line; the Red River on the Dakota line; the Mississippi starts in Lake Itasca and is navigable from Minneapolis southward.

3. Distribution: Two-fifths of the State is prairie, adjoining the Dakota and Iowa lines; another fifth, next to prairie, shows hardwoods prevailing over the softwoods; the remaining two-fifths is pine land and swamp land.

The northwestern pine belt of the United States reaches its western limit in Minnesota. The species prevailing in the hardwood belt are black oaks, sugar maple, birches and cottonwood. In the pine belt, white pine, Norway and jack pine are found, according to the soil. The poorer the soil, the more jack pine. White pine occurs, usually, with an undergrowth of linden, maple and hazel. In the swamps, black spruce, balsam, white spruce, white cedar and tamarack. On the wind-swept side of lakes, conifers are missing. No hemlock is found, a fact denied by H. B. Ayres. Birches and poplars occupy cut-over white pine land and secure, acting as nurses or ushers, if fire is kept out, a gradual recurrence of white pines. White pine underneath white pine is never found, whilst Norway pine immediately replaces Norway pine, and whilst jack pine invariably follows in jack pine's wake.

4. Forest ownership: 85 lumber firms own 2,025,000 acres of 3,900 feet average stumpage per acre. State owns between 2 and 3 million acres of land forfeited for non-payment of taxes. The United States own enormous tracts still. 30 townships remain unsurveyed north of the continental divide. Large Indian reserves.

5. Use of timber: The value of the products of the lumber industry in Minnesota gives it third rank as a lumber producing State. Minnesota came slowly to the front, having in 1880 an output of $7,400,000; in 1890, $25,000,000, and in 1900, $43,600,000.

The cut in 1900 consisted of:—

| | |
|---|---|
| White pine | 2,250,000,000 feet b. m. |
| Norway pine | 108,000,000 feet b. m. |
| Other conifers | 20,000,000 feet b. m. |
| Spruce | 1,000,000 feet b. m. |
| Hardwoods | 62,000,000 feet b. m. |
| Total | 2,441,000,000 feet b. m. |

The miscellaneous industries (furniture, cooperage, wagon stock, flooring, spools, etc.) yielded, in 1900, only $1,300,000. White pine and hardwoods in Minnesota are, on the average, inferior to white pine and hardwoods in Wisconsin and Michigan.

404 saw mills of $60,848 average investment (maximum investment, by far, of United States). Logging by rail is taking the place of log driving, on which the mills of Minneapolis used

to depend. Skidding by horses during the winter months forms the rule. Sleighing over ice roads to the lakes or rivers. Wages of workmen about $28 (with full board) per month. Large amount of timber consumed by the iron mines of northeastern Minnesota. Logs are worth $3.40 on stump, and $8.09 at mill.

The leather industry is small, hemlock lacking. Nine tanneries use 107 cords of bark, 37 barrels of extract and a little gambier and quebracho.

Relative to paper and pulp industry, no data are given by the 12th census. Possibilities are very good, since there is plenty of spruce. Big Weyerhauser mill near Duluth.

6. Forestry movement: Since 1876 a forestry association encourages prairie planting. Bounties for prairie planting since 1891. Arbor Day since 1883-1884. The Hinckley fire, of September 1, 1894, through which a large number of lives and many millions of dollars worth of stumpage were lost, caused the creation of a forest fire warden system, effective enough to prevent a second Hinckley conflagration, but insufficient for the absolute safety of forestal investments. The legislators hailing from the prairies antagonize outlays benefitting the wooded portion of the State. The State auditor is "forest commissioner."

Town supervisors and the mayors of cities are constituted fire wardens and are fined for neglect of duty. Remuneration only $2 per day for not to exceed 15 days annually (two-thirds paid by county and one-third by State). The chief fire warden ($1,200 salary) is appointed by the State auditor; he maintains and superintends the activity of the fire wardens; has authority to mass them at points of danger; controls an emergency fund of $5,000 for suppression of fires. Annual forest statistical reports of great value, by General C. C. Andrews.

Forestry lectures by Prof. S. B. Green at the Minnesota State College of Agriculture.

The proposition to establish a national park at the Chippewa Indian reserve ceded to the United States was enthusiastically upheld by the Minnesota Federation of Women's Clubs and by the railroads. The influence of the lumbermen caused partial defeat of the park bill. As the law stands, the agricultural lands of the Chippewa reserve are to be opened to settlers; the pine lands, after the timber is sold at public auction, will form (without the President's proclamation) a national forest reserve. 5%

of the timber, however, will be left according to the selection of the Bureau of Forestry.

The friends of forestry now endeavor to obtain a national park in the northeast, close to Lake Superior.

7. Laws: "Staples bill" forbids the removal of timber previous to payment of back taxes.

"Cross bill," of 1899, makes State forestry feasible on land either donated by lumbermen or set aside by the State for reserve purposes. Practically no appropriation and practically no donations. Companies are forbidden to own over 5,000 acres of land. Fire warden law, see under "forestry movement."

8. Reservations: The Lake Itasca State forest reserve is insignificant.

The Chippewa or "Minnesota National" forest reserve will be gradually established after timber is sold, and is expected to finally comprise 225,000 acres.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF MISSISSIPPI:

1. Area: Area of woodlands, 32,300 square miles, or 70%.

2. Physiography: Alluvial and diluvial soil. Huge bottoms between Mississippi and Yazoo Rivers. The Pearl River on the Louisiana line. The Tombigby River drains the northeastern part.

3. Distribution: Originally the forest was half pine and half hardwood. Long leaf pine prevails in the south, extending northward to the latitude of Vicksburg and Meridian, on sandy soil, especially on former dunes. A belt along the Mississippi, some 30 miles wide, is free from long leaf pine. Cuban pine, with the long leaf, up to 60 miles from the coast, occupies moist soil, on which it regenerates freely. It is not found west of the Pearl River. Echinata is not found close to the coast, beginning where Cuban pine ends. It often appears mixed with long leaf and taeda pine, and prevails on the divide separating the Tombigby from the Yazoo Rivers on 5,000 square miles. Trees are more scattering than in Texas and Arkansas, the hardwoods taking a larger share in the composition of the forest. Taeda occurs everywhere east of the Yazoo, from the coast up to the Tennessee line, under the name of short straw pine, lob-

lolly, swamp, slash and rosemary pine. It occupies moister and more loamy soil, and is often found in inundation districts. The undergrowth or suite consists of black and sweet gum, red oak and magnolia on wet soil; of hickories, Spanish oak and black jack on drier soil. Spruce pine (glabra) occurs in small clumps on rich, terraced soil. Cypress fills huge swamps along the Mississippi and Yazoo Rivers. White cedar occurs, with taeda, in half-swamps.

In the bottom lands are found cottonwood, both gums, white oak, cow oak (prevailing); Texan oak, water oak (nigra), magnolia and beech. Further, walnut, shagbark hickory, yellow poplar, sycamore, mulberry, elm and holly. Burr oak and red oak are here wanting. Overcup oak (lyrata) occurs under the name "swamp oak."

4. Forest ownership: 349 firms own 1,214,000 acres, stocked with 7,600 feet b. m. per acre. The United States, the State and railroads, notably the Mobile and Ohio, own large tracts. The balance is owned by farmers.

5. Use of timber: In the census year, 820 mills of $9,400 average investment. In 1900, log value on stump, $1.30; at mill, $4.60. The output of the saw mills was valued in

| | |
|---|---|
| 1880 at | $ 1,900,000 |
| 1890 at | 5,700,000 |
| 1900 at | 15,600,000 |

The cut in the census year consists of

| | |
|---|---|
| Yellow pine | 964,000,000 feet b. m. |
| Other conifers | 37,000,000 feet b. m. |
| Cottonwood | 39,000,000 feet b. m. |
| Red gum | 23,000,000 feet b. m. |
| White oak | 102,000,000 feet b. m. |
| Other hardwoods | 42,000,000 feet b. m. |
| Total | 1,207,000,000 feet b. m. |

Hardwood logging is very expensive; yellow pine logging, with four yoke of oxen hitched to a high-wheel cart, is very cheap. The average logging distance, for pine, slightly exceeds one-third of a mile. Expense of logging (cutting and hauling), $1.25; of railroading, 50 cents per 1,000 feet b. m.

Railroad grades are fearful. Minimum log diameter of long leaf pine admitted is 10 inches. Average log size about 220 feet b. m.

Turpentine industry is now tapping the pole-woods as well as the tree-woods. Lumbermen box two or three years before cutting. Echinata and heterophylla as well as palustris are boxed.

Leather industry: Insignificant.

Paper and pulp industry: None.

6. Forestry movement: None.

7. Laws: Firing on vacant land is allowed only during the three spring months. On appropriated land, malicious firing only is prohibited.

8. Reservations: None.

9. Irrigation: In 1899, 40 acres were irrigated; 30 acres in rice and 10 in truck.

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## FORESTRY CONDITIONS OF MISSOURI:

1. Area: 41,000 square miles, equal to 60% of the area of the State, are classed as woodlands.

2. Physiography: The Mississippi River forms the eastern line; the Missouri River traverses the State from west to east. Undulating plains. Highest mountains are the Ozarks, from 800 feet to 1,000 feet high.

3. Distribution: The northwestern portion is prairie, with the usual forest groves along the rivers. The south-southeastern part exhibits short leaf pine (echinata) on the hills, notably on the Ozarks, alternating with stretches of post oak barrens. The undergrowth underneath pine is formed by oaks (scarlet, black, post, white), hickories and black gum. Altogether, 3,000,000 acres of pine are said to be found, the average stumpage being only 2,000 feet b. m. (after Mohr, often 3,000 to 4,000 feet b. m.). The lower dells of the east, south of the Missouri, show splendid broad leaf forests, where oak, walnut and ash, of prime quality, are still found away from the railroads. In the deep swamps of the southeast, cypress and tupelo gum prevail. In shallow water, swamp maple, swamp plane tree, swamp white ash and water honey locust occur. In the damp woods, gigantic cottonwoods, burr oaks, gums and cypresses. Here, perhaps, is

the best remaining supply for white hickory. Gigantic Texan oak, sweet gum, willow, water and scarlet oak are also met.

4. Forest ownership: In south, much forest owned by speculators. 274 lumber firms control 869,545 acres, of 5,500 feet b. m. average stumpage. Farmers own two-thirds of woodlands. State owns 500,000 acres.

5. Use of timber: 1,169 (!) mills, with an average investment of $5,336, beset the forests. Large cooperage concerns using cottonwood, elm and oak. White oak cut for railroad ties and bridge timber. Stumpage price averages $1.89. Logs at mill worth $6.91.

Leather industry uses 774 cords of hemlock bark, 2,936 cords of oak bark and 869 barrels of bark extract. Output of industry, $816,000.

The cut of the census year was:—

| | |
|---|---|
| White oak ............. | 250,000,000 feet b. m. |
| Pine .................... | 269,000,000 feet b. m. |
| Cypress ................ | 10,000,000 feet b. m. |
| Cottonwoods ........... | 76,000,000 feet b. m. |
| Elm .................... | 28,000,000 feet b. m. |
| Red gum .............. | 51,000,000 feet b. m. |
| Other hardwoods ....... | 35,000,000 feet b. m. |

No paper and pulp industry. Value of saw mill products rose from 6.3 million dollars, in 1870, to 11.2 million dollars in 1900.

Hardwood bottoms are invariably thought to be convertible into excellent farm lands.

6. Forestry movement: Arbor Day established in 1886. Forestry lectures at State Agricultural College. Residents seem to vie with one another to steal the timber belonging to non-residents.

7. Laws: Fire fines up to $500. No inclination of jurors to punish timber theft and incendiarism.

8. Reservations: None.

9. Irrigation: No data available.

---

## FORESTRY CONDITIONS OF MONTANA:

1. Area: 42,000 square miles, or 29% of State, is wooded.

2. Physiography: The 109th meridian divides Montana in half. The eastern half consists of high plains fit for pasture

only, traversed by the Missouri and Yellowstone Rivers, the courses of which are cut 600 to 900 feet deep into the plateau. This eastern half contains, practically, no forests.

The western half contains barren land only in the extreme north (Maria River Basin). Three main mountain chains may be distinguished in the western half.

(1) The Coeur d'Alene and Bitter Root Mountains on the Idaho line. Water runs towards the Pacific from both slopes via Columbia River.

(2) The main Rockies, lying between the Flat Head Basin and the Missouri River, which drain westward on the west slope and eastward on the east slope.

(3) The northern extension of the Yellowstone Range extending northward to the center of the State. Water runs from both slopes entirely towards the Atlantic, via the Yellowstone and Missouri Rivers.

All these mountains are less rugged and by 3,000 feet lower than those in Colorado and Wyoming.

3. Distribution: The best forests of Montana and of the entire Rockies are found in the chain of the Coeur d'Alene and Bitter Root Mountains. On the mountain chain forming the crest of the continent the forests are equal to the best of those in Wyoming. On the third mountain range, draining solely eastward, the forests are equal to those of the Yellowstone region.

The western cedar (plicata) is scarce and small. It is found in best valley soil only at low elevations. Lowland fir and Engelmann's spruce occur in moist bottoms associated with Douglas fir. Lodgepole pine forms very extensive forests at medium altitudes. Limber white pine and balsam (lasiocarpa) are found in great bodies, especially on the eastern drainage; larch, white pine (monticola) and hemlock prevail on mountains draining towards the west. Along the rivers, cottonwoods and box elders occur. Quaking aspen replaces the conifers after heavy burnings on north slopes.

4. Forest ownership: Lumbermen own very small tracts only, since taxes are high. Indian reservations and railroad grants cover large tracts. (Northern Pacific and Great Northern Railroads.) The forest reserves cover about 7,500,000 acres. Over one-fifth of Montana still belongs to the United States.

5. Use: The mining interests of Montana stand paramount. Montana is second in the production of gold and silver,

and first, by far, in the production of copper, amongst the States of the Union.

Next in importance are the livestock interests. The stock consists of:—

1,000,000 cattle.
2,800,000 sheep.
200,000 horses.

The forest is meant to subserve the mines, supplying props, fuel and ties; and agriculture, supplying water for irrigation purposes. To the west are the large plains of Washington. To the east those of the Dakotas and Montana, which can be irrigated only, it is claimed, by using water coming from the Montana Mountains. Log stumpage is worth $1.18 on an average, and logs at mill $4.11. Mill investments average $13,475. 38 lumber firms control about 600,000,000 feet stumpage, said to average 6,600 feet per acre.

Mill products were worth in

| | |
|---|---|
| 1870 | $ 430,000 |
| 1880 | 527,000 |
| 1890 | 1,182,000 |
| 1900 almost | 3,000,000 |

In 1900 the cut of timber was 257,000,000 feet b. m., three-fifths of which was yellow pine, the balance consisting mainly of red fir and tamarack.

The destruction by fire is said to be beyond belief.

6. Forestry movement: Numerous petitions to Congress led to the establishment of the central reserves. Geo. P. Ahern delivered lectures on forestry at the Montana College of Agriculture, at Bozeman, for a number of years.

7. Laws: Penalty for wilful or careless firing. County commission required to keep fire laws posted. Tax rebate on forestry plantations.

8. Reservations: Only 690,000 acres of the Bitter Root reserve lie in Montana. The Flathead forest reserve, comprising 1,382,400 acres, and the Lewis and Clarke forest reserve, comprising 2,926,080 acres, both lying on the crest of the Rockies, have been recently combined into one reserve under the name of the latter. At the same time, the reserved acreage was increased, making the new "Lewis and Clarke forest reserve" 4,670,270 acres.

The Gallatin forest reserve of only 40,320 acres, near Bozeman, is unimportant.

The Madison forest reserve (736,000 acres), bordering the Yellowstone Park, and the Little Belt Mountain forest reserve (501,000 acres), both established in 1902, seem important for irrigation at the head of the Missouri and Yellowstone Rivers. On the Lewis and Clarke forest reserve, western larch is by far the prevailing species, having twice the stumpage of Douglas fir and five times the stumpage of yellow pine. In the same reserve there seems to be more spruce than either yellow pine or lodgepole pine. The Canadian larch and spruce are sentinels of the British Columbia forest flora.

The Absaroka forest reserve of 1,311,600 acres, recently established, lies north of the Yellowstone Park. It has been consolidated with the Yellowstone and Teton reserves by Presidential proclamation.

9. Irrigation: Montana is third in irrigation, 950,000 acres being irrigated. Irrigation practicable only near the mountains at the present moment. Irrigation necessary for the cultivation of crops, notably barley.

The canal of the Minnesota and Montana Irrigation Company in Yellowstone County is 40 miles long, with an average width of 35 feet and a depth of 5 feet. Another canal in Chateau County is 75 miles long.

The great eastern plains, with very rich soil, are almost unsettled, owing to the difficulty of irrigation. The best farms are found in the Gallatin Valley, near Bozeman, and along the Yellowstone River.

Winter forage is required for the development of the rapidly increasing livestock interests.

In 1889, 950,000 acres of irrigated farm land produced $7,300,000 worth of crops from irrigation works constructed at an expense of $4,700,000.

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## FORESTRY CONDITIONS OF NEBRASKA:

1. Area: 2,300 square miles, or 3% of the area of the State, are wooded.

2. Physiography: Prairie traversed by the Platte River midway from west to east. The Niobrara flows along the north-

ern boundary line; the Missouri forms the eastern boundary line towards Iowa.

One quarter of the State north of the Platte River is occupied by the "Sand Hills," which are not sand dunes, but give rise to springs and offer pasture.

3. Distribution: In the broad Missouri Valley of the extreme east were once found splendid groves of hardwoods, notably of burr oak, walnut, ash, box elder, honey locust and Kentucky coffee tree. The canyons of the rivers coming from the west show cottonwoods, willows and red cedar. Further west, some yellow pine, quaking aspen, cottonwoods and birches occur. Yellow pine covers several narrow ridges 5,000 feet high near the Wyoming line. Red cedar is found sparingly everywhere, the original growth being cut away for fence posts.

In the Sand Hills, logs and stumps of yellow pine are found buried in the sand. After Dr. C. E. Bessey, pine groves (ponderosa) were found 50 years ago even in the eastern half of the State. About 300,000 acres (?) of forest plantations are now in existence. Honey locust, cottonwood and green ash are said to do best. The European pines are reported thrifty.

4. Forest ownership: The federal government still owns the Sand Hills. 321,000 acres of forest along the rivers are attached to farms.

5. Use of timber: The hardwoods of the Missouri bottoms are practically used up. In 1880 there were 38 firms producing annually 14,000.000 feet of cottonwood and burr oak lumber. In 1900, 23 mills, of $1,900 average investment, were in existence. Output in 1900 is not given. Stumpage is worth $2.29 per thousand, and logs at mill bring $5.69.

Firewood and fence posts are the leading requisites.

Leather and pulp industry: None.

6. Forestry movement: John Sterling Morton, Cleveland's Secretary of Agriculture, was the soul of a vigorous movement in favor of prairie forest planting. He introduced Arbor Day.

A State agricultural society offers three premia to the largest tree planters.

The "Nebraska Park and Forest Association," founded in 1899, tries to influence the newspapers.

Instruction in forestry at the University of Nebraska by Dr. C. E. Bessey.

7. Laws: Tax exemption laws of 1869 were found unconstitutional. Towns are required by law to plant trees and authorized to levy taxes for that purpose. There are the usual fire laws.

8. Reservations: The Dismal River forest reserve (85,123 acres) and the Niobrara forest reserve (123,779 acres) are to be planted up, by the federal government, in yellow pine, jack pine and red cedar.

9. Irrigation: 148,000 acres of irrigated farm land have produced, in the census year, $983,000 worth of crops, helped by irrigation works costing $1,000,000.

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## FORESTRY CONDITIONS OF NEVADA:

1. Area: Under forest is 200,000 acres, or 0.3% of the State. Wooded area, after census of 1900, is 3,904,000 acres, or 6% of the State.

2. Physiography: In the western part, the east slope of the Sierras, with Virginia City and Carson City. Scarcely any water leaves the State. In the central part, narrow mountain ranges run north and south, and rise to over 8,000 feet altitude.

3. Distribution: Stunted junipers, and above these mountain mahogany (Cercocarpus ledifolius) skirt the barren land. Higher up, slopes dotted with nut pine, and still higher with yellow pine (Jeffreyi and ponderosa). The limber white pine is said to form extensive forests at elevations from 7,000 to 10,000 feet.

4. Forest ownership: Mines and railroads own little. The United States own practically all of Nevada. The State obtained from Congress a grant of 2,000,000 acres, to be located as the State pleased, in place of the usual school sections 16 and 36. The State sold the 2,000,000 acres rapidly in large tracts along all water courses at $1.25 per acre to cattle men.

5. Use: Mining timber is paramount. Limber pine, yellow pine and red fir (magnifica) are used for props. The timber works of the Comstock mines are said to be of marvelous construction. Since 1870, $55,000,000 worth of timber is said to have been buried in the mines. Nut pines, mountain mahogany and juniper are used for fuel and charcoal. Lumber is worth $23 per thousand; mine props, $10 per cord.

FOREST POLICY.

6. Forestry movement: Nill.

7. Laws: None.

8. Reservations: None.

9. Irrigation: A State irrigation law of 1903 declares all water courses public property and fixes maximum use of water per acre of irrigated land.

The development of the State depends on the possibility of constructing reservoirs (notably on Humboldt River) and on the chances of artesian wells.

The existing irrigation works, costing $1,500,000, irrigate 500,000 acres of land and produced, in 1899, $2,800,000 worth of products.

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## FORESTRY CONDITIONS OF NEW HAMPSHIRE:

1. Area: 5,200 square miles, or 58% of the State, are wooded.

2. Physiography: Northern section of the State is mountainous, containing the headwaters of the Androscoggin, Merrimac and Connecticut Rivers ("the Switzerland of America"). Mount Washington, in the Presidential Range of the White Mountains, is 6,290 feet high. Southern section of the State is hilly, with some peaks over 3,000 feet high. Many summer tourists attracted.

3. Distribution: The growing stock was and is formed of white pine, hemlock, spruce, balsam and cedar, mixed with sugar maple, birch, beech; further, chestnut, ash, basswood and oak. After Fernow, hardwoods with spruce prevail in the northern section; pine and hemlock in the southern section. In 1900 the lumbermen alone owned 3,800,000,000 feet b. m. of stumpage, 2,000,000,000 feet of which are spruce. Large areas stock themselves with white pine after lumbering. Since 1850, 1,750,000 acres of improved farm land have reverted to unimproved land, most of which is coming up in white pine.

4. Forest ownership: 159 lumber firms own 664,000 acres of forest, 43% of the woodlands are attached to farms. Paper companies and speculators own very large tracts.

5. Use of timber: The forest has been culled for decades of years—to begin with, of prime white pine only. Fires used

to be severe. The stand of virgin spruce often averages 20,000 feet b. m. per acre on large tracts. Logging by water or by rail. Some firms begin to survey the sleigh roads with great care. Stumpage costs $2.68; logs at mill cost $6.96 per 1,000 feet b. m. The State contains 535 saw mills, of $10,200 average investment.

The output of the saw mills was valued in

| | |
|---|---|
| 1850 | $1,100,000 |
| 1860 | 1,200,000 |
| 1870 | 4,300,000 |
| 1880 | 3,800,000 |
| 1890 | 5,600,000 |
| 1900 | 9,200,000 |

The cut of 1900 consisted of

| | |
|---|---|
| Spruce | 188,000,000 feet b. m. |
| White pine | 310,000,000 feet b. m. |
| Hemlock | 45,000,000 feet b. m. |
| Other conifers | 2,000,000 feet b. m. |
| Hardwoods | 23,000,000 feet b. m. |

The miscellaneous mill stock produced in 1900 was worth $875,000. Hoop poles, excelsior, shoe pegs and maple sugar are produced in large quantities.

Leather industry: 12 tanneries report an annual output of $2,265,000 of leather and a consumption of 5,700 cords of hemlock bark, worth $25,400; 712 bales of gambier, worth $4,600; 40 barrels of bark extract, worth $480, and of chemicals, worth $6,400.

Paper and pulp industry: 29 firms produce an output worth $7,200,000. The raw material consists of domestic spruce, 109,000 cords. worth $655,000; Canadian spruce, 87,000 cords, worth $479,000; other wood, 720 cords, worth $3,430.

6. Forestry movement: A Forest Commission, appointed in 1881, submitted a good report in 1885. Lectures on forestry are offered at the State Agricultural College. The inhabitants are not inclined to check forest fires.

The "White Mountain State Park" movement, in 1892, failed to be successful.

A bill of 1901, intended to limit the cutting of conifers to trees of over 10 inches stump diameter, failed to become a law.

## FOREST POLICY.

The "Society for the Protection of the New Hampshire Forests" employs a forester (Philip W. Ayres) and intends to work the park scheme through Congress. Its propaganda, based on merely economic grounds, is most commendable.

7. Laws: A law of 1893 establishes a forestry commission, consisting of the governor and four members appointed by him. The member acting as secretary draws a salary of $1,000. Duties of commission are:—

(a) Gathering forest, lumber and fire statistics.

(b) Forestry propaganda at public meetings.

(c) Suggesting legislation in annual reports.

(d) Appointment (since 1895) of special fire wardens upon application by forest owners, applicant and county equally sharing the expense of the service.

In organized towns, the selectmen are fire wardens ex officio, paid by the town.

Where no town organization exists, the county commissioners are empowered to appoint fire wardens serving at the county's expense.

Fire laws are uninforced.

A law of 1903 provides $5,000 for the examination, by the National Bureau of Forestry, of the White Mountain forests. A joint resolution of the Legislature authorizes the federal government to establish, by expropriation or otherwise, a national forest reserve in the White Mountains.

8. Reservations: None.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF NEW JERSEY:

1. Area: The woodlands cover 3,234 square miles, or 43% of State. The forest area is said to be increasing.

2. Physiography: The Delaware River and the Delaware Bay on the west side; Hudson River, Raritan Bay and Ocean on the east side. Shipping facilities and sea climate supply New Jersey with economic and forestal conditions similar to those of England. A belt 12 miles wide, stretching along a line running

from Wilmington, Del., to Hoboken, is covered by cretaceous clays and marls. North of this belt lies the mountain zone of New Jersey, formed of red sandstone with trap outcrops, replaced further north by gneiss and granite highlands and yielding, in the extreme north, to the limestone and slate formations of the Kittatinney Mountains.

South of the cretaceous belt lie "The Pines," a slightly rolling plain, with gravelly and sandy soil of post-tertiary origin.

3. Distribution: All timber is second or third growth. In the clay and marl belt, chestnut coppice prevails in small wood lots attached to farms; growth thrifty, protected by farmers. Pinus virginiana and echinata are found, with little rigida.

In the highlands and mountains of the north, the farm lots in the valleys are well stocked with hardwoods, especially chestnut. In the Kittatinney Mountains, conifers, especially Pinus rigida, are mixed with hardwoods. Slopes and ridges are invariably in woods. In the mountains, tracts are large and hence more frequented by fires and trespassers.

In "The Pines," pure pitch pine forests of a stunted growth prevail on pure sand, the trees formed by stool-shoots after fires. On better soil, black oak and black jack oak are mixed with pitch pine. On wet soil dense stands of white cedar occur, or hardwood swamps, stocked with sweet and black gum, maple and yellow poplar.

The trap rock ridges, breaking through the red sandstone, show a stunted coppice growth of poor oak, chestnut and red cedar.

The woodlands of the northern highlands and those of "The Pines" may be of indirect importance by shielding the water supply for a growing population.

A colony of Russian Jews practice osier culture for basket-making.

4. Forest ownership: 47 mill firms own 7,576 acres of forest, reported to contain 3,600 feet b. m. average stumpage. The balance of woodlands belongs to farmers and to owners of small private reserves.

5. Use of timber: The iron industry in "The Pines," during the 18th century, drew heavily upon the virgin forest for charcoal. In 1850 the whole State was already cut over.

The output of the saw mills was valued in

| | |
|---|---|
| 1850 | $1,123,000 |
| 1860 | 1,608,000 |
| 1870 | 2,745,000 |
| 1880 | 1,627,000 |
| 1890 | 1,225,000 |
| 1900 | 1,859,000 |

The cut in 1900 consisted of:—

| | |
|---|---|
| Yellow pine | 27,000,000 feet b. m. |
| White cedar | 10,000,000 feet b. m. |
| Other conifers | 4,000,000 feet b. m. |
| Chestnut | 10,000,000 feet b. m. |
| Oak | 19,000,000 feet b. m. |
| Other hardwoods | 3,000,000 feet b. m. |
| Total | 73,000,000 feet b. m. |

Logs on stump are worth $3.93; at mill, $7.56. 197 saw mills exist, of $4,357 average investment. The miscellaneous wood industries furnish only $157,000 worth of stock. The consumption of forest products, other than lumber, is said to consist of 800,000 cords of wood for fuel, 1,250,000 railroad ties; 14,000 telegraph and trolley poles and $365,000 worth of fencing. The usual rotation in coppice woods and pineries is from 35 to 50 years.

Leather industry: 77 tanneries produce $13,700,000 worth of leather and consume 4,016 cords of hemlock bark, worth $39,600; 15,150 cords of oak bark, worth $170,830. In addition, large amounts of gambier, quebracho, sumac and chemicals are used for tanning.

The paper and pulp industry works in 34 plants, producing $3,200,000 worth of paper. No cord wood, however, is used. The raw material consists of rags, straw, pulp and fiber obtained from outside the State.

6. Forestry movement: Public opinion is well aware of the benefits derivable from a sound forest policy. Forestry bills are continuously introduced and continuously fail of passage.

The Geological Survey of New Jersey, since 1885, deals with the forest problem, and, under a law of 1894, has issued, in 1899, a very good report on the forests of the State. No action was taken upon it. A State Forestry Association seems to have died. The splendid public road law of New Jersey should greatly facilitate conservative forestry. What New Jersey needs is an enthusiastic and unselfish leader of propaganda for forestry.

7. Laws: Since 1792, county officials act as fire wardens and are privileged to summon help. Railroads are responsible for damages caused by spark fires, and locomotives must be supplied with spark arrestors. The "Minch bill," of 1902, providing salaried fire marshals, seems to have failed. Arbor Day since 1884.

8. Reservations: None, except small private reserves.

9. Irrigation: Only on 73 acres producing hay, vegetables and corn.

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## FORESTRY CONDITIONS OF NEW MEXICO:

1. Area: 23,700 square miles, equal to 19% of total area of Territory, are wooded.

2. Physiography: Rocky Mountains traverse Territory from north to south. Average elevation of Rockies, north of Santa Fe, 10,500 feet. Drainage chiefly towards the Gulf of Mexico, via the Rio Grande from the west slope of the Rockies, and via Pecos and Canadian River from the east slope of the Rockies. River beds sunken 200 feet into the table lands. Rainfall averages less than one inch per month, except in the higher altitudes. Mean altitude of the whole territory is about 5,600 feet.

3. Distribution: Arid plains east of the Pecos River (Llano Estacado), with some mesquit. In the southwest, narrow mountain ranges separate wide plains on which Madrona, Spanish Bayonet and Palo Verde grow. "Journanda del Morte," along the Mexican frontier, is said to be the worst of all deserts. The mesas show scattering scrub oak with groups of red cedar, western juniper and pinon. In the depressions of the mesas occur fine groves of mesquit. Splendid grazing on the mesas. Along the rivers appear fringes of box elders, willows and cottonwoods. The mountain ranges show, at the highest elevations, a cupressus species forming dense forests (probably Arizonica); lower down, on the north slopes, white pine (flexilis), Douglas fir and Engelmann's spruce, which are replaced, after heavy cuttings and burnings, by quaking aspen. On south slopes

yellow pine preponderates in open forests (ponderosa). The foothills show juniper, cedar, pinon, scrub oak. The best forests are in the central north and in the southwest, where the diagonal mountain chain traversing Arizona enters the territory.

4. Forest ownership: Lumbermen own 1,518,000 acres. Attached to farms are 10% of the forests. The railroads and mines are said to control large tracts. Reservations cover 3,258,080 acres, equal to 4% of the territorial area.

5. Use: Forests are mostly used for pasture, especially in the yellow pine region. In the foothills' forests, yellow pine is the most valuable timber. Cedar and juniper are used for fence posts. Scrub oaks and pinion are used for fuel. In the census year the cut was 203,000 feet b. m. of Engelmann's spruce and Douglas spruce, and 31,637,000 feet. b. m. of yellow pine, averaging 1,700 feet b. m. to the acre. Merchantable timber is found only on the higher mountains. Mill investments average $5,200. Lumbermen control 1,000,000,000 feet b. m. of spruce and 1,300,000,000 feet of yellow pine. No pulp or leather industries. Stock raising stands paramount. Fires are said to do little damage, excepting north of Santa Fe.

6. Forestry movement: None.

7. Laws: Usual fire laws. Liability for all damages. Denver and Rio Grande railroad is the only road privileged to cut timber for repairs from government land.

8. Reservations: The Pecos River reserve, of 431,000 acres, lies northeast of Santa Fe and comprises the sources of the Canadian and Pecos Rivers.

The Gila River forest reserve is large (2,327,040 acres) and compact and drains, through the Rio Grande, westward into the Pacific. In July, 1902, the Lincoln forest reserve of 500,000 acres was created in the central south of the Territory.

9. Irrigation: 88,900 acres. Agriculture possible only in the cañons of the main rivers, depending on irrigation.

The Aborigines have irrigated their farms from time immemorial on. Agricultural chances are best along the southern broad-bottomed course of the Rio Grande. Ditches, roughly constructed, are usually held in common by the Mexican inhabitants. The farms have the form of oblongs, the narrow side joining the river.

The largest reservoir is on the Pecos River, in the southeast of the State near Carlsbad.

The irrigation works existing in 1889 were constructed at an outlay of $4,100,000 and irrigate 204,000 acres of farm land, producing $2,800,000 worth of crops.

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## FORESTRY CONDITIONS OF NEW YORK:

1. Area: 18,700 square miles, or 39% of the State, are classed as woodlands.

2. Physiography: Whole State slightly mountainous. Western section more level. Catskills on west bank of Hudson; Adirondacks in extreme north, rising in Mount Marcy to an elevation of 5,345 feet (with gneiss and granite for underlying rock). A large number of inland lakes in north and west facilitate transportation.

3. Distribution: The western section is the farming section of the State. Originally the broad-leafed forest of the Mississippi Basin covered the entire State, excepting:—

(a) The Adirondacks, where maple, birch and beech prevail in irregular mixture with spruce, hemlock, white pine and red pine, the spruce forming pure stands on the poorest soil, whilst wet depressions are occupied by balsam, tamarack and white cedar.

(b) The low hills bordering the Hudson and extending westward along the Pennsylvania line, in which the coniferous species of the northern pine belt preponderate.

In 1900, the forests, with the exception of those in parts of the Adirondacks, consist of second growth. Many a so-called "virgin forest" of the Adirondacks has lost its stand of white pine for many a year.

4. Forest ownership: 276 firms own 648,000 acres, stocked with 5,600 feet b. m. per acre. The State reserves comprise 1,325,000 acres in the Adirondacks and 82,000 acres in the Catskills.

5. Use of timber: The stand of conifers in New York was estimated, by Sargent, in 1880, at 8.3 billion feet b. m., and by Fernow, in 1896, at 5.3 billion feet b. m.

## FOREST POLICY.

The value of the output of the saw mills, since 1850, shows unexplainable fluctuations. It was in

| | |
|---|---|
| 1850 | $13,100,000 |
| 1860 | 9,700,000 |
| 1870 | 21,200,000 |
| 1880 | 14,300,000 |
| 1890 | 17,100,000 |
| 1900 | 15,800,000 |

New York stepped down gradually, as a lumber producing State, from first rank in 1850 to 12th rank in 1900.

The cut in 1900 consisted of:—

| | |
|---|---|
| Hemlock | 314,000,000 feet b. m. |
| Spruce | 256,000,000 feet b. m. |
| White pine | 122,000,000 feet b. m. |
| Other conifers | 6,000,000 feet b. m. |
| Maple | 51,000,000 feet b. m. |
| Oak | 43,000,000 feet b. m. |
| Basswood | 30,000,000 feet b. m. |
| Elm | 16,000,000 feet b. m. |
| Chestnut | 14,000,000 feet b. m. |
| Birch | 13,000,000 feet b. m. |
| Ash | 9,000,000 feet b. m. |
| Hickory | 1,000,000 feet b. m. |

Stumpage is worth $3.12, and logs at mill are bought at $7.75 on an average. 1,742 mills report an average investment of $6,163. The shingle production is valued at $342,000; the production of miscellaneous stock at $1,101,000. In barrel and box manufacture, further, in the manufacture of baskets and woodenware, New York occupies first place amongst the States. 159 box factories turn out $7,900,000; 413 barrel factories, $6,500,000; 180 basket and woodenware factories, $1,000,000.

The expense of logging in the Adirondacks averages $4.50 per 1,000 feet b. m. Horses only are used in skidding and sleighing. Logs are driven down the rivers, frequently with the help of splash dams.

The average growing stock in primeval parts of the Adirondacks shows, per acre, 31.5 spruces, 4.5 hemlocks, 4 balsams, 0.2 white pines, 0.1 cedar, 14 birches, 10 beeches, 6 hard maples, 2.5 soft maples and a few ash and cherry, making a total stand of 73.4 trees of over 10-inch diameter per acre.

Leather industry: 147 tanneries yield annually $23,200,000 worth of products and consume 179,000 cords of hemlock bark, worth $1,200,000; 4,000 cords oak bark, worth $33,000; 19,000 bales of gambier, worth $123,000, 2,100 barrels of hemlock bark extract, worth $25,000; 526 barrels of oak bark extract, worth $5,500; 615 barrels of quebracho, worth $9,500; 2,150 tons of sumac, worth $104,000; and chemicals, worth $330,000.

Paper and pulp industry: New York leads the United States, in the 12th census year, by producing $26,700,000 worth of pulp and paper. 179 firms consume: Home-grown spruce, 363,000 cords, worth $1,985,000; Canadian Spruce, 141,000 cords, worth $945,000; domestic poplar 32,000 cords, worth $181,000; Canadian poplar, 9,600 cords, worth $57,000; other pulp wood, 9,500 cords, worth $40,000. After Fernow, more spruce is now consumed for pulp than for lumber.

6. Forestry movement: New York, as late as 1884, was still the owner of some woodlands in the Adirondacks, and Catskills. The Adirondack Park Association stimulated further acquisitions by the State. The New York State college of forestry was expected to demonstrate the feasibility of practical forestry on 30,000 acres of experimental forest and to supply the State with scientific foresters.

7. Laws: Law of 1886 allows the State to pay taxes on her own land.

Law of 1889 provides penalty of $25 for every tree cut or stolen from the State's land.

In 1897, the Adirondack Park law was enacted.

Since 1893, forest utilization in the Adirondack forest preserve is forbidden by a constitutional clause.

In 1895, the Forest Commission was combined with the Fish and Game Commission (See XXXI.).

In 1900, the office of chief fire warden was created and the Commission authorized to employ three expert foresters to act as deputy fire wardens, attend reforestation, etc.

In 1901, the Forest, Fish and Game Commission was consolidated with the Forest Preserve Board. D. C. Middleton, of Watertown, is the forestry member of the Commission. Col. Wm. F. Fox is Forest Superintendent. The law makes it the duty of the Commission

(a) To take care of the State forest preserves.

(b) To promote "further growth" in the preserves.

(c) To husband the people's interests in forestry and tree planting, and especially with reference to forest fires. The law authorizes the Commission to employ a superintendent, an assistant superintendent, a land clerk, 12 "foresters and game protectors" and 35 "forest rangers," the latter drawing a salary of $500 per annum.

Outside the State preserves the town supervisors act ex officio as "fire wardens," empowered to summon help (at $2 per diem) and instructed to annually report to the Commission on the number, extent and cause of forest fires occurring in their respective precincts; further, on the remedial measures taken to fight fires. The town pays half of the fire warden's wages ($2.50 per diem).

If the fire wardens neglect proper discharge of their duties, then the Justices of the Peace or the Commissioners of Highways shall act as fire wardens in their stead.

Aside of these fire wardens ex officio, the Commission may rely, "in forest towns," on the vigilance of fire wardens specially appointed by the Commission. A forest town may be subdivided into two or more fire warden districts.

In 1901, the chief fire warden had a force of 617 fire wardens at his command, with whom he kept in contact by continuous visits. A booklet, "Instructions to Fire Wardens," was issued in 1901.

The negligent or wilful firing of woodlands is punishable by a fine ranging between $50 and $500.

8. Reservations: The Adirondack Park exists only on the map and comprises that land which eventually should become the property of the State. It covers 3,226,144 acres, including over 2,000,000 acres of private holdings. The Adirondack forest preserve (the majority of), which lies inside the park, comprises 1,163,414 acres. It is entirely (excepting a few cases of divided rights) owned by the State, and contains 450,000 acres of forest proper, 590,000 acres of woodlands heavily lumbered, 40,000 acres of deforested land, 60,000 acres of water surface, 4,600 acres in farms. The spruce stumpage on the preserve is estimated to be 1.5 billion feet b. m.

The Catskills forest preserve comprises only 82,330 acres.

Both preserves are gradually increased by purchase, the prices ranging from $1 to $9 per acre. Tree planting on waste land, within the preserve, was begun in 1902.

9. Irrigation: 123 acres on 11 farms producing vegetables and tobacco.

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## FORESTRY CONDITIONS OF NORTH CAROLINA:

1. Area: 35,300 square miles of woodlands, or 73% of the State, are reported as "mostly timbered."

2. Physiography: The western mountain region occupies 6,000 square miles. It is formed by the Blue Ridge on the South Carolina line and the Great Smokies on the Tennessee line. Cross ridges connecting these chains show the highest elevations. Mount Mitchell, of 6,711 feet elevation, is the highest mountain east of the Rockies. Normal precipitation, 57 inches annually. Normal average temperature, 50 degrees F. Rivers running northward, breaking independently through the Great Smokies.

The Piedmont plateau, 400 to 1,500 feet high, occupies 22,000 square miles. Its configuration is rolling, in the west hilly. This fertile plateau is drained by the Catawba and Yadkin Rivers; further, by the headwaters of the Cape Fear, Neuse and Roanoke Rivers. Its elevation averages about 900 feet above sea level; its precipitations, 50 inches; its annual temperature, 59 degrees F.

The coastal plain of North Carolina, an area of 24,000 square miles, falls from 400 feet elevation down to sea level. North of the Neuse River the soil is loamy; south of it more sandy. Normal precipitations, 55 inches. Normal temperature, 61 degrees F. Large swamps along coast.

3. Distribution:

(a) Mountain region:

(1) Lower mountains. There are 6 species of oaks, 4 of hickories, chestnut, dogwood, black gum, sourwood and chinquapin. Post and Spanish oak are said (by W. W. Ashe) to be rather local. Pinus echinata, rigida, virginiana, strobus and (after Ashe) pungens prevail. White pine is said to cover 200,000 acres, notably in counties close to the Virginia line, reaching its finest development at altitudes ranging between 2,800 and 3,800 feet elevation. The lower mountains are practically deprived of virgin growth.

(2) Higher mountains. (3,000 feet to 5,000 feet elevation.) On the north slopes, hemlock, birches (lutea and lenta), red oak,

beech, basswood, cherry, yellow poplar, white ash, cucumber, chestnut and buckeye occur, frequently with a dense undergrowth of rhododendron.

On the south slopes, white, scarlet and chestnut oaks; chestnut, locust and hickory prevail. Table mountain pine on dry ridges. North Carolina hemlock on eastern slopes. Woods virgin.

(3) Mountain summits (over 5,000 feet elevation). Black spruce (Picea rubens) and balsam (Abies fraseri) cover the mountain sides, protected from storms. Buckeye, beech and sweet birch; further, mountain ash are mixed with the soft woods, the two first named often in groups.

The undergrowth is a tangle of laurels standing on a dense matting of mosses. On the wind-swept side of the mountains "balds" occur, fit only for pasture, covered with Ericaceae, dotted with stunted red oaks, chestnuts and a locust here and there

(b) Piedmont plateau. Uplands show an irregular mixture of broad-leafed species (notably black oak) with pines (echinata and taeda). On red sandstone a pure growth of taeda and echinata is frequently found without admixture of hardwoods. On fertile red clay (tobacco land), hardwoods (black, white and red oak; white, shagbark and small nut hickory; yellow poplar; white ash) occur without pines. The virgin forest is practically removed. Along the large streams, sweet and black gum, overcup and swamp (cow) oak, sycamore and hackberry occur. Along the smaller streams are found red and white oak, yellow poplar, beech, maples and hop hornbeam.

(c) Coastal plain. Maritime forests along seashore are broad-leafed and evergreen, composed of water (nigra), laurel (laurifolia) and live (virens) oak, devilwood (Osmanthus americana), mock orange (Prunus caroliniana), sweet bay, yaupon (Ilex vomitoria) and palmetto. The pine belt uplands, adjoining the maritime forests, show long leaf pine or taeda or both, according to fertility of soil. The lowlands in the pine belt exhibit so-called "Oak Flats," with cow, overcup, white, water and Spanish oaks, in company with ash, elm, gum, cottonwood and red maple; or swamps stocked with gum and cypress; or so-called "Bays," where white cedar prevails; or "Pond pine swamps," formed by Pinus serotina, mixed with oaks and taeda pine.

4. Forest ownership: 629 lumber firms control 1,714,000 acres. Balance of woodlands is owned by farmers and speculators.

5. Use of timber: There are altogether 1,751 saw mills. The average mill investment is $3,572. The mill output in North Carolina amounted in the year

| | |
|---|---|
| 1850 to | $ 900,000 |
| 1860 to | 1,100,000 |
| 1870 to | 2,000,000 |
| 1880 to | 2,700,000 |
| 1890 to | 5,900,000 |
| 1900 to | 14,900,000 |

The cut of 1900 consisted of:—

| | |
|---|---|
| Yellow pine | 1,228,000,000 feet b. m. |
| Cypress | 31,000,000 feet b. m. |
| Other conifers | 11,000,000 feet b. m. |
| Poplar | 51,000,000 feet b. m. |
| White oak | 86,000,000 feet b. m. |
| Other hardwoods | 8,000,000 feet b. m. |

The naval store products, in 1885, were $1,320,000. Then, already, the industry was on the decline, the output having decreased (after Fernow) since 1880 by 30%. The main shipping points for naval stores are Wilmington and Norfolk. After Sargent, the stand of yellow pine, in 1880, was 5,200,000,000 feet b. m. Since 1880, however, at least 15 billion feet of yellow pine have been cut. The stumpage in the mountain section after H. B. Ayres and W. W. Ashe, in 1901, amounts to 10,650,000,000 feet b. m. or 2,640 feet b. m. to the acre. In addition, the stand of firewood in the mountain section is estimated to be 16.83 cords per acre. The various species participate in said stumpage as follows:—

| | | | |
|---|---|---|---|
| Oaks | 41.41% | Chestnut | 17.20% |
| White pine | 2.68% | Hemlock | 5.30% |
| Spruce | 0.80% | Poplar | 1.85% |
| Ash | 1.43% | Buckeye | 2.00% |
| Basswood | 2.69% | Black gum | 1.64% |
| Beech | 1.06% | Cucumber | 0.84% |
| Maple | 2.67% | Birch | 3.03% |
| Pitch pine | 1.34% | Hickory | 3.16% |
| Locust | 0.67% | Echinata | 0.43% |
| | | Miscellaneous | 9.80% |

The miscellaneous industries (producing stock for furniture, wagons, agricultural implements, lath, bobbins and spools), in 1900, show an output of $644,000.

Little cooperage stock (value $30,000) and boxes (value $76,000) were produced. Logs on stump are worth $1.34; at mill, $4.45.

The leather industry consumes, in the census year, in 75 tanneries, 1,808 cords of hemlock bark, worth $8,524; 20,467 cords of oak bark, worth $107,242; 270 barrels of oak bark extract, worth $3,294. The value of the leather produced is $1,502,000.

The paper and pulp industry is nill. The spruce forests of the high mountains are still inaccessible; in addition, freight rates are too high for good prospects of paper mill investments.

6. Forestry movement: The "North Carolina Forestry Society" is inactive. A forester, attached to the North Carolina Geological Survey, draws $1,000 per year salary (W. W. Ashe).

7. Laws: Good fire laws, on the statute book, are a dead letter, since there is no staff charged with their enforcement. A recent law, practically prohibiting the export of logs for manufacture, is, probably, unconstitutional.

8. Reservations: The "Appalachian National Park" (or Reserve?), now planned, is located, largely, in the Great Smokies of Western North Carolina. Congress is asked to appropriate $10,000,000 for the establishment of such a park covering 4,000,000 acres. North Carolina and the adjoining States have passed laws authorizing the United States to establish and manage such a park. Main difficulty to be met is the problem of local taxation.

9. Irrigation: 101 rice plantations, covering 3,283 acres, or 15% of the total area in rice, were irrigated in 1899, producing 30% of the total rice yield of the State.

Tide water is utilized for irrigation. The cost of the system averages $34.35 per acre.

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## FORESTRY CONDITIONS OF NORTH DAKOTA:

1. Area: 600 square miles are wooded, an area equal to 1% of the entire State. No State of the Union has a smaller percentage of wooded area.

2. Physiography: Plains are unsheltered from the north. There are low hill ranges near the Canadian line, i. e., Turtle Mountains. The Missouri, after taking in the Yellowstone River, runs eastward and then southward through the State. The Red River of the North forms the boundary towards Minnesota.

3. Distribution: All river bottoms show disconnected groups of burr oak (macrocarpa), sycamore, cottonwood, box elder and green ash. The low northern mountains contain cottonwoods mainly.

4. Forest ownership: Several thousand acres (40,000?) of artificial forest planted under the timber culture act.

5. Use: Hardwoods used for firewood. Near Canadian line. wood is worth $1.50 per cord. Building timber obtained from Minnesota. Twelfth census reports 4 saw mills of $2,000 average capital. Logs worth $1 on stump and $5 at mill. No pulp and no leather industry.

6. Forestry movement: An association formed in 1887 seems to have died since. The timber culture act gave rise to enthusiastic but mostly unsuccessful planting. Arbor Day movement since 1884. Much interest in forest planting maintained by the press.

7. Laws: A bounty of $2 annually to everyone planting one acre or more in trees. A plantation of five acres exempts a quarter section, plus $1,000 worth of improvements, from taxation for ten years. Usual prairie fire laws. Owner must fire his land in March, April or May, and give 24 hours' notice of his intention to do so to all people living within one mile.

8. Reservations: None.

9. Irrigation: Possibility of reclamation along main Missouri River is limited.

The irrigated area, in 1899, aggregated less than 5,000 acres, yielding crops worth $28,000.

Only $18,000 has been spent for irrigation systems up to 1899.

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## FORESTRY CONDITIONS OF OHIO:

1. Area: Originally entire State was wooded. Forest area statistics are annually derived from data furnished by tax

assessors. In 1853 forest area was 55%; in 1870, 38%; in 1886, 22%; in 1896, 17.4%. After the 12th census, however, the area of woodlands was 23% of area of State, or 9,300 square miles.

2. Physiography: No mountains, no dry or rocky soil. Undulating, rich table land, every square foot fit for agricultural purposes. Lake Erie in the north and Ohio River in the South facilitate transportation.

3. Distribution: Scattering groves of long boled hardwoods appear everywhere (hickory, sycamore, oaks, chestnut, ash, maple, yellow poplar, walnuts, elm, beech, etc.). Original forest is, probably, left in swamps only. White pine along the Pennsylvania line in a narrow belt.

4. Forest ownership: All woodlands are attached to farms, except 80,700 acres, of 4,100 feet b. m. average stumpage, controlled by lumber mills.

5. Use of timber: Ohio occupies seventh rank as a lumber producing State of the Union, having maintained its position admirably in spite of reports of declining supplies. Ohio leads in the production of furniture stock. Logs are worth at mill $9.47, and on stump, $4.92. There are 2,023 mills, of $4,638 average investment. Value of products of lumber industry averaged, in 1870, 1880, 1890 and 1900 respectively, $10,000,000, $14,000,000, $15,000,000 and $21,000,000.

The cut in 1900 consisted of:—

| | |
|---|---|
| White oak ............ | 593,000,000 feet b. m. |
| Other hardwoods ...... | 325,000,000 feet b. m. |
| Conifers .............. | 42,000,000 feet b. m. |

Leather industry: 58 tanneries use 5,500 cords of hemlock bark, 23,800 cords of oak bark, 10,000 barrels of bark extracts and a little gambier, quebracho and sumac. Total product of tanneries equals $5,200,000.

Paper and pulp industry has 51 plants using rags, waste paper, straw and manila grass preferably, in addition to 5,000 cords of home-grown (?) spruce, 2,000 cords of Canadian spruce, 10,000 cords of home-grown poplar, 2,000 cords of Canadian poplar and 12,000 cords of miscellaneous woods.

6. Forestry movement: State Forestry Association inactive. Woodland is considered only as farmland bearing the wrong crop. A bill for forestry school defeated in 1897.

## FOREST POLICY.

Forestry lectures by Wm. R. Lazenby, at State University.

Cincinnati Forestry and Improvement Association formed in 1903.

7. Laws: Fire laws since 1805. State forestry bureau created in 1885. Officers unsalaried and now inactive.

8. Reservations: None.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF OKLAHOMA AND INDIAN TERRITORY:

1. Area: In Indian Territory, 65% of the total area or 20,000 square miles are wooded.

In Oklahoma, 11% of total area or 4,400 square miles are wooded.

2. Physiography: Undulating plateau, drained by rivers flowing west to east, notably the Canadian River and Cimarron River. The Red River of the south forms the southern boundary.

The highest mountain ranges in the Ozark plateau are the Arbuckle and the Boston Mountains. The Cross timbers enter from Texas.

The Wichita Mountains, in the southwest, are over 2,000 feet high.

3. Distribution: Western section is prairie, with green ash, hackberry and cottonwood along the rivers. Red cedar is said to have been found 20 years ago on the edges of all canyons.

Middle section has woodlands of blackjack oak and post oak, notably in the Cross Timbers. Further, some burr oak, hackberry, white oak, shittim wood and wild china berry tree occur. These species are said to be gradually extending towards the west. After W. L. Hall, black walnut, catalpa and locust can be planted successfully within the original oak forests.

In the eastern section (Indian Territory), south of the Canadian River, Pinus echinata and taeda are found in large, valuable bodies on the ridges. The lowlands in the east are splendidly timbered with the hardwoods of the Mississippi bottoms. Here the best black walnut of the United States is said to exist. Further, red oak, cow oak, hickories, white ash, gums, cottonwood, sycamore, mulberry, maple, osage, orange and pecan.

4. Forest ownership: In Indian Territory, 32,347 acres are owned by lumbermen, with stumpage averaging 3,800 feet per acre.

In Oklahoma, lumbermen own 10,940 acres, of 1,300 feet average stumpage.

5. Use of timber: In Indian Territory, the sawn products of 1900 were valued at $200,000, consisting of 16,000,000 feet b. m. Logs on stump worth $1.21 and logs at mill worth $4.61. There were 48 mills, representing an average investment of $1,911.

In Oklahoma there were 33 mills, of $1,423 average investment, which have turned out, in the census year, $63,000 worth of lumber. Logs on the stump are worth $2.54 and at mill $5.82.

Leather, paper and pulp industries: None.

6. Forestry movement: Some forest planting in Oklahoma.

7. Laws: Unknown.

8. Reservations: The Wichita forest reserve, of 57,120 acres, in the Wichita Mountains of Oklahoma.

9. Irrigation: Irrigation is unimportant, being practiced, in 1899, on 2,300 acres only.

The systems of irrigation cost $22,000.

The irrigated crops are valued at $16,000.

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## FORESTRY CONDITIONS OF OREGON:

1. Area: The forests occupy 34,750,000 acres, equal to 57% of total area of State. Fernow gives only 20,000,000 acres and the vice-president of the defunct Oregon Forest Association only 16,000,000 acres of forest. Reason for difference is the difference of definition of forest. The great commercial forests cover about 10,000,000 acres.

2. Physiography: Coast Range separated from the Cascade Range by the Willamette, Umpqua and Rogue Rivers. The heavy rainfall in the Coast Range is due to the Japan current (Kuroshivo). In the northeastern part of the State the Blue Mountains extend into Washington. The southeastern third of the State is without forests, exhibiting deserts close to Nevada.

3. Distribution: Similar to that in Washington.

(a) Coast Range. Tideland spruce close to the ocean. The bulk of the forests consist of Douglas fir and red cedar. Lawson's cypress forms a forest of great commercial value in the southern third of the Coast Range, where it exhibits splendid silvicultural qualities, i. e., abundant regeneration. In the extreme south of the Coast Range, sugar pine, winter bald white oak and also California chestnut oak are met with.

(b) Cascade Range. On west slope, most important tree is Douglas fir, forming pure forests below 2,000 feet elevation and reproducing splendidly on clearings. Red cedar, hemlock and, higher up, white pine (monticola) are next in importance to Douglas fir. The firs (noble, amiable and grand) run high up on the mountains, fringing Crater Lake (10,000 feet elevation). In southern extension of cascades, sugar pine occurs.

On east slope: Below 5,000 feet an open forest of yellow pine is found; above 5,000 feet, Douglas fir, lodgepole pine and lowland fir are mixed with yellow pine. In addition, Engelmann's spruce, western larch and white pine occur. At timber line white bark pine and hemlock are found in open forests.

The river bottoms between Coast Range and Cascade Range exhibit heavy, broad-leaved groves composed of cottonwoods, alders, ashes, willows and white maples; also the evergreen California laurel.

(c) The Blue Mountains (in northeast corner of State) show open stunted forests of yellow pine, Douglas fir and larch, and, above 4,000 feet elevation, a heavy growth of lodgepole pine.

4. Ownership: Farmers own 1.5 million acres.

Lumbermen, mostly Michigan and Wisconsin men, composing 212 firms, control 825,000 acres, of 25,000 feet b. m. per acre average.

United States reserves cover close to 4.5 million acres on the Cascade Range. None exist on the Coast Range.

The Warm Springs and Klamath River Indian reservations cover about 1,000,000 acres each, but are not heavily forested.

5. Use: The hardwoods are largely used for woodenware, cooperage and furniture. The California laurel is the finest wood for cabinet work and ship building on the coast. The center of the hardwood industries is Portland. The cut in the census

year was 740 million feet b. m. only, which is equal to 0.3% of the growing stock of 225 billion feet b. m. This growing stock is composed as follows:—

| | |
|---|---|
| Red fir ........................ | 150 billion feet b. m. |
| Yellow pine ................... | 40 billion feet b. m. |
| Hemlock, spruce and cedar ..... | 35 billion feet b. m. |

Mills smaller than in Washington, the average investment being $12,300. Stumpage prices lower than in any other State, being 66c. per 1,000 feet b. m. Saw logs at the mill cost $4.46 per 1,000 feet b. m.

The paper and pulp industry used in 1900, 150,000 cords of spruce in 5 establishments. The leather industry had 16 tanneries, worth $11,000 on an average, reporting to be annually using altogether 936 cords of hemlock bark and 1,247 cords of oak bark (?).

Very important for Oregon is the live stock industry.

The stock consists of

14,000,000 cattle,
24,000,000 sheep,
2,000,000 horses,
500,000 mules.

Sheep are driven to the summer range in the high cascades, so as to leave all pasture in the lowlands to the heavier stock.

Annual value of the wool product is over $1,500,000. In the reserves, only 60 owners with 188,000 sheep in 86 bands.

6. Forestry movement: In 1888-1889 Legislature petitions Congress to establish reserves. In 1897 outbreak of antagonism against "Reserve Policy," backed by the Wool Growers' Association (John Minto).

In 1898 forest reserves were opened to limited sheep pasture, and the antagonism to reserves has since subsided.

7. Laws: State fire laws of 1893 impose fines on malicious or careless firing of woods, but are ineffective. The public domain is protected under special fire laws. New fire law of 1903 was passed by both houses, but vetoed by governor.

8. Reservations: Reserves cover 13% of wooded area and 7.2% of total area of State.

The Ashland forest reserve (18,560 acres) in the extreme south and the Bull Run timber land reserve (142,080 acres) in the extreme north of the Cascade Range are small and unimportant. The Bull Run reserve includes Mount Hood. Between the two reserves stretches the Cascade Range forest reserve, a reserve of 4,436,120 acres enclosing the Crater Lake National Park of 150,000 acres. The reserves extend, practically, from the Washington line to the California line, are 50 to 100 miles wide, lie largely above 7,500 feet above sea level and include many summits above timber line.

9. Irrigation. The agricultural development of central Oregon depends on the possibility of utilizing for irrigation the scanty and intermittent streams of the region.

The success of a deep well system would allow of an enormous increase of the cattle and sheep industry.

In 1899, 388,000 acres of farm land, producing $3,100,000 worth of crops, were irrigated from works constructed at an outlay of $1,800,000.

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## FORESTRY CONDITIONS OF PENNSYLVANIA:

1. Area: The woodlands comprise 23,000 square miles, or 51% of total area. The forest is said to be, in a great part, depleted of its merchantable timber.

2. Physiography: A belt of mountains 50 miles wide and 240 miles long traverses the State diagonally from southwest to northeast. The mountain ranges are from 1,000 to 2,000 feet high, Negro Mountain forming the highest peak, at an altitude of 2,826 feet.

Northwest of the mountain belt are the broad Allegheny Uplands, rolling high plateaux covering over one-third of the State. Southeast of the mountain belt appears the northern extension of the Coastal Plains at an average elevation of 500 feet. The Susquehana drains the eastern half of the State, together with the Delaware on the New Jersey line.

3. Distribution: Pennsylvania was originally covered from end to end with heavy forests. White pine and hemlock formed vast forests on both flanks of the Alleghanies. East and west of the mountains the conifers gave way gradually to a heavy growth of broad-leaved species.

In the southeastern section, white oak was and is the most valuable species. The second growth of hardwoods is otherwise composed of hickories and birches; further, chestnut, locust, maple, walnut and cherry.

In the Allegheny Uplands the hardwoods of the Mississippi are found, notably, red and white oak, beech and sugar maple. In the southwest of this region occur the Kentucky coffee tree, honey locust, chestnut and yellow poplar. West of the Allegheny River no white pine, but some hemlock occurs. East of this river, hemlock; then white pine increases in proportion on the way toward the mountains.

In the mountain belt prevail, below 1,800 feet, white pine, hemlock, pitch pine, sugar maple, black and yellow birch, beech and cherry. On rocky soil, especially in the southern part, occur chestnut oak, chestnut and locust. Above 1,800 feet the Canadian tree flora sets in, consisting of spruce (Picea rubens), balsam and larch, with some white pine, Norway (red) pine and hemlock. White pine stands averaging 25,000 feet b. m. per acre on tracts comprising several hundred acres are no longer found.

In 1880 white pine virgin forests occurred only island-like on their original domain, whilst hemlock was then scarcely touched.

In 1900, on burned white pine slashes, yellow and black birch, bird and black cherry, maple, chestnut and beeches come up in profusion.

Regeneration of hemlock is nill; that of white pine very poor.

In 1896, Dr. Rothrock and Dr. Fernow estimated the stand of conifers as follows:—

| | |
|---|---|
| White pine ........ | 500,000,000 feet b. m. |
| Spruce ............ | 70,000,000 feet b. m. |
| Hemlock .......... | 5,000,000,000 feet b. m. |

4. Forest ownership: In 1894, over 1,500,000 acres, i. e., over 5% of State's area, were advertised for sale by the counties for tax forfeiture.

614 lumber firms own 645,000 acres of forest, said to be stocked with 9,300 feet b. m. on an average.

83% of the woodlands are said to be attached to farms.

The State reserves now aggregate several hundred thousand acres.

5. Use of timber: Logs on stump are worth $2.94; at mill, $6.71. 2,280 mills report an average investment of $10,083. Penn-

sylvania, leading the United States lumber industry in 1860, has dropped to fourth rank in 1900, although she succeeded in vastly increasing the value of her output within these 40 years.

The output was in:—

| | |
|---|---|
| 1860 | $11,000,000 |
| 1870 | 29,000,000 |
| 1880 | 22,000,000 |
| 1890 | 29,000,000 |
| 1900 | 36,000,000 |

The cut in 1900 consisted of:—

| | |
|---|---|
| Hemlock | 1,608,000,000 feet b. m. |
| White pine | 238,000,000 feet b. m. |
| Other conifers | 19,000,000 feet b. m. |
| Chestnut | 51,000,000 feet b. m. |
| Oak | 342,000,000 feet b. m. |
| Other hardwoods | 140,000,000 feet b. m. |
| Total | 2,398,000,000 feet b. m. |

The shingle mills turned out, in the census year, $370,000 worth of shingles, largely using the old remnants of white pine and hemlock, also a little oak and chestnut.

Cooperage stock produced in 1900 was valued at $762,000 (notably for sugar barrels); the miscellaneous industries furnished $1,443,000 worth of home-grown stock. Very little wagon and furniture stock.

In forest utilization, the rivers, notably the Susquehana, are made use of. Skidways and sleds are little used. The logs are moved over so-called "slides," V shaped troughs, consisting of hemlock poles placed on hemlock ties, with an ice crust formed by sprinkling. Six to forty peeled logs form a log train, pulled by horses in a tow path.

At the Williamsport boom, the proportion of hemlock and pine logs was, in 1875, 1 to 10; and in 1893, 5½ to 1.

Leather industry: Pennsylvania excels amongst the States of the Union in the output of the leather industry, which output is valued at $55,615,000. 254 tanneries consumed, in the census year, 565,062 cords of hemlock bark, worth $3,460,000; 64,392 cords of oak bark, worth $437,000; 2,800 bales of gambier, worth $17,000; 304 barrels of hemlock bark extract worth $3,368; 5,615 barrels of oak bark extract, worth $56,700; 3,775 barrels of quebracho, worth $50,700; 206 tons of sumac, worth $10,000. The chemicals used were worth $919,600.

The output of Pennsylvania's tanneries is mostly sole leather.

In paper and pulp industry, Pennsylvania has 4th rank, producing $12,268,000 worth of paper in 73 mills and consuming: Home-grown spruce, 16,697 cords, valued at $85,504; Canadian spruce, 25,442 cords, valued at $167,200; other pulp wood, 2,262 cords, valued at $11,000.

6. Forestry movement: Pennsylvania is more awake to the necessity of forest preservation than any other State, thanks to the energy of Dr. Rothrock. A Forest Association backs his work and publishes "Forest Leaves," since 1885. Forestry lectures are occasionally given at the universities. Arbor Day since 1886.

7. Laws: Since 1887, forest plantations of at least 1,200 seedlings enjoy a tax reduction of 90% to their tenth year; of 80% to their twentieth year, and of 50% to their thirtieth year. From 10th year on, 600 saplings per acre are considered a sufficient growing stock. Similar inducements are granted to owners of second growth, consisting of sound tree seedlings, covering not to exceed 50 acres.

In 1897, the Forest Commissioner was authorized to purchase forfeited land at a price not to exceed back taxes and other "unseated" land at a price of not over $5 per acre, such lands to become part of a forest reservation system.

The constables of townships are ex officio fire, fish and game wardens, entitled to a premium of $10 for each offense (fire) reported. They are privileged to summon help, and obliged to report to the court of quarter sessions any case of violation of fire, fish and game laws.

The expense of the fire warden system is equally divided between county and State. The county, however, is not required to incur an outlay exceeding $500 per annum.

The law of 1897 authorizes the acquisition of three tracts at the head waters of the Delaware, Susquehana and Ohio Rivers by expropriation for the forest reserve. Each tract is to comprise 40,000 acres in a solid body.

In 1901 the Division of Forestry was raised to the rank of a department.

The revenue from the reserves is to be divided between township and State, to reimburse the former for the inevitable loss of taxes. The forest commissioner, as superintendent of the reserves, is empowered to enact rules for management and protection of the reserves; may employ detective service and lawyers in case of forest fires; must publish forest statistics, and may spend $25 annually per mile for improvement of public roads in the reserves, $12.50 per mile for improvements outside the reserves.

The reserve policy is handicapped by a constitutional clause forbidding the State to take up loans for such purposes of investment as a forest reserve represents.

8. Reservations: 575,000 acres of State forest reserves have been created within four years, during the administration of Governor Stone. The reserves are scattered over 22 counties. Only two reserves cover an acreage exceeding 100,000 acres.

9. Irrigation: 758 acres are irrigated; 93% of this land yields hay crops valued at $23.64 per acre.

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## FORESTRY CONDITIONS OF PHILIPPINE ISLANDS:

1. Area: After Capt. Geo. P. Ahern, 25% to 50% of the islands (or an area of 20,000,000 to 40,000,000 acres) are public forest lands. Mindoro and Paragua contain 5,000,000 acres of virgin forest. Mindanao is almost entirely covered with virgin timber (20,000,000 acres).

2. Physiography: The Philippines, consisting of more than 1,000 islands, separate the Pacific from the Chinese Ocean. The configuration is mountainous, with active volcanos in the south. Mount Apo, on Mindanao, is over 10,000 feet high. The climate is tropical; rainy period from June to November; dry spell from December to May.

3. Distribution: The number of native tree species approximates 700.

4. Forest ownership: The federal government and, to a certain extent, religious orders, own all forest land.

5. Use of timber: Forest utilization suffers from the difficulty of transportation, the lack of efficient labor and the variety of growing stock, containing a large number of commercially untested species.

Gum, rubber and gutta percha trees, dye woods, ylang-ylang, cocoanut palms (in Romblon), etc., have been utilized under Spanish rule.

The occurrence of a pine (Pinus insularis) in a tropical climate is geographically interesting.

The price of logs in Manila ranges from 60c. to $3 (Mexican) per cubic foot. Carabao oxen are used in log transportation. Lumber is hand sawed by the natives. The white ant is the enemy destroying all lumber and timber used and utilized, excepting three or four species.

6. Forestry movement: A Bureau of Forestry, established under G. P. Ahern, succeeded the Spanish forest administration (since 1863) after American occupancy in 1898. The administrative staff is now supplied by American foresters passing the civil service examinations.

The forestry movement centered in the bureau is, naturally, in the direction of forest exploitation only. The botanical and technical characteristics of the timber species are studied and tested. All timber cut on public land is cut by license. Forestry officials, stationed at all important logging centers, inspect, stamp, classify and appraise all shipments of timber cut under license. The cutting of certain species and of certain sizes of trees is prohibited on public land.

The licensee pays from 1c. to 14c. (Mexican) per cubic foot of timber removed from public land.

A forestry school, after the pattern of Dehra Dun, India, should be organized.

7. Laws: The Spanish forestry laws and regulations have been adopted with slight alterations—a course highly commendable.

8. Reservations: None.

9. Irrigation: Not applicable.

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## FORESTRY CONDITIONS OF PORTO RICO:

1. Area: The island area totals 2,304,000 acres. It is dotted with many trees, park-like; but deforested as a whole, with the exception of eight square miles of inaccessible primeval forest on Mount El Yunque.

2. Physiography: The climate is tropical. The south is drier than the north. The mountains (volcanic) are continuously bathed in moisture.

3. Distribution: The mountain tree flora is composed of a large number of species, including palms and tree ferns, none of commercial importance.

The coastal forest is said to be often chaparal-like.

Fruit trees (orange, lime, lemon, banana) are common all over the island.

The coffee plantations often appear as dense forest thickets.

4. Forest ownership: No information available. The federal government owns but little land.

5. Use of timber: Fruit trees are most valuable. There is not one saw mill in the island. Natives drag logs cut and roughly squared to the nearest oxe-trail. Logs are often whipsawed into planks or boards. About $300,000 worth of timber and timber products are annually exported.

6. Forestry movement: None. Avenues of shade trees frame the Spanish highways. Reforestation of denuded slopes seems advisable.

7. Laws: No information available.

8. Reservations: The Luquillo forest reserve, in the eastern part of the island, was established on January 17, 1903.

9. Irrigation: For the cultivation of the staple crops of the south coast, irrigation is practiced with great skill and at considerable expense.

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## FORESTRY CONDITIONS OF RHODE ISLAND:

1. Area: Area of woodlands, 400 square miles or 40% of the State.

2. Physiography: Flat and sandy. Maritime climate.

3. Distribution: Originally all the island was covered with forest. Now, coppice of chestnut, oak, hickory, ash and birch, with some stray white and pitch pine, are found to form a meager second growth. Trees along the coast are stunted and scarce.

4. Forest ownership: 13 lumber firms own 1,673 acres. Balance of woodland is attached to farms.

5. Use of timber: Firewood commands a high price, owing to density of population (250 pro square mile). Stumpage costs \$3.02; logs at mill cost \$7.15 per 1,000 feet b. m. 33 saw mills report an average investment of \$3,131. The census gives the value of the output of the lumber mills, since 1870, at about \$250,000 annually.

The cut in 1900 is reported to consist of 18,000,000 feet b. m., including 14,000,000 (?) feet b. m. of white pine.

Leather industry: 5 tanneries, of \$293,000 output, consume 26 cords of hemlock bark, worth \$260, and \$5,000 worth of chemicals.

There is no paper or pulp mill.

6. Forestry movement: None. Some private plantations on sand land.

7. Laws: Fire laws. No case was ever prosecuted.

8. Reservations: None.

9. Irrigation: 2 farms produce on 40 acres \$32,000 worth of vegetables (?).

---

FORESTRY CONDITIONS OF SOUTH CAROLINA:

1. Area: 20,500 square miles, or 68% of total area, are said to be stocked, generally, with merchantable forest. Sargent's estimate of yellow pine supplies, existing in 1880, was 5.3 billion feet b. m.

2. Physiography: On the North Carolina line, in the extreme northwest, the Blue Ridge Mountains. The Piedmont plateau lies to the east and south of these mountains and extends to a line 150 miles from the coast, where the lowlands of the coastal plain set in.

3. Distribution: In the tier of mountain counties occur the species typical for the southern Appalachians (see Georgia). In the Piedmont section, the hardwoods (especially white, chestnut and red oaks, poplar, hickory, ash, chestnut and cottonwood) occur with Pinus taeda and (less) echinata. The coastal plain has long leaf pine for the main timber tree. Cubensis gives out near Charleston. On moist ground, Pinus taeda of splendid growth, often mixed with red oak and white cedar. Huge swamps are occupied by cypress and gums, the hummocks showing elm, hick-

ory, yellow poplar and red oak. The coast swamps are lined with live oak, magnolia and bays, often with palmetto for an undergrowth.

4. Forest ownership: 251 lumber firms own 454,000 acres of 4,400 feet b. m. average stumpage. Vacant State lands were sold at auction for a song, about 1895.

5. Use of timber: South Carolina seems backward in the lumber industry. The activity was never great. The rivers are not as good for rafting as those in adjoining States, being bordered by broad swamps. Logs are worth $1.23 on stump and $4.16 at mill. Mill investments average $4,097, with 716 firms. The output was valued in

| | |
|---|---|
| 1880 | $2,000,000 |
| 1890 | 2,100,000 |
| 1900 | 5,200,000 |

The cut of 1900 consisted of:—

| | |
|---|---|
| Cypress | 32,000,000 feet b. m |
| Yellow pine | 433,000,000 feet b. m. |
| White oak | 11,000,000 feet b. m. |
| Other hardwoods | 6,500,000 feet b. m. |

In 1880, South Carolina lead in the production of tar and turpentine. Since then, the industry was forced westward.

The miscellaneous forest industries (furniture, wagon, cooperage stock, etc.) produced $168,000 in the 12th census year.

The leather industry is very small, using 305 cords of oak bark and producing $18,000 worth of goods.

The paper industry is nill.

6. Forestry movement: Nill.

7. Laws: Stock law prevails over entire State. Fire law provides heavy fines for firing turpentine orchards.

8. Reservations: None.

9. Irrigation: 648 planters irrigate, in 1899, 30,000 acres of rice fields. Rice irrigation has been practiced in South Carolina since 1700.

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## FORESTRY CONDITIONS OF SOUTH DAKOTA:

1. Area: 2,500 square miles, equal to 3% of the area of the State, are wooded.

2. Physiography: Missouri River running from north to

south to the center of the State and thence towards the southeast corner. Mountains appear only in the southwest, i. e., the Black Hills on the Wyoming line, drained by the Cheyenne River. A strangely large number of rivulets have their sources in South Dakota.

3. Distribution: South Dakota, like all other prairie States, is the meeting ground of the eastern and western tree flora, the former represented by the hardwood groves in the river bottoms (burr oak predominating, in addition, sycamore, cottonwood, willow, box elder, green ash); the latter (western flora) occurring on hillsides and represented by western yellow pine. This species shows in the Black Hills splendid natural regeneration and better trunks than in the Rockies. White spruce (canadensis) occurs in the Black Hills near streams, on high northern slopes. Aspen and canoe birch appear on moist slopes in dense thickets after fires.

4. Forest ownership: Farmers own little aside from prairie plantations. Six lumber firms control 6,000 acres. The federal government has reserved 76% of the wooded area in the "Black Hills reserve."

5. Use: Yellow pine only used for timber and for the lead mining interests centering at Deadwood. The cut of timber in census year equals 30,000,000 feet b. m., drawn from a growing stock of 1,500,000,000 feet b. m. Logs are worth, on stump, $1.80 per thousand; at mill $5.25. There are 28 saw-mills of $5,000 average investment. 5,000 head of stock find pasturage in the hills. A plague of bark beetles occurred in 1900. Hardwoods largely used for firewood and fences. Planted forests have perished, usually through fire or neglect, in the majority of cases.

6. Forestry movement: Arbor Day for ornamental planting. South Dakota Agricultural College makes tree planting experiments and issues bulletins bearing on forestry questions.

7. Laws: As in North Dakota.

8. Reservations: The Black Hills forest reserve comprises 1,211,680 acres, one-third of which lies in Wyoming. The opportunity for forest management in this reserve is unrivalled. The financial problem is easy, since stumpage values are high and the demand good. The silvicultural problem is easy, since regeneration is excellent, and since only one species has to be dealt with. There are no "weed trees." Finally, utilization is easy, the moun-

tains having gentle slopes. Even firewood can be disposed of to a certain extent. Fires and insects, however, handicap the forester's work.

The Wind Cove national park, in the southern Black Hills, created in 1902, is said to be a Yellowstone without geysers.

9. Irrigation: During the census year, 44,000 acres of farmland, irrigated from works (notably deep artesian wells) costing $285,000, produced crops valued at $208,000.

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## FORESTRY CONDITIONS OF TENNESSEE:

1. Area: 27,300 square miles, or 65% of the State, are under forest.

2. Physiography: Vast bottom lands along the Mississippi, subject to inundation. Cumberland River in the north and Tennessee River in the south. Cumberland and Alleghany Mountains in the east, the latter with summits over 6,000 feet high. Low mountain ranges in central part.

3. Distribution: The Mississippi bottom lands show gigantic hardwood forests without undergrowth and a sprinkling of swamps stocked with cypress, red and black gums. Cypress is said to be of poor quality. Amongst the hardwoods are found cottonwoods, gums, red and cow oaks, hickories, elms, beeches and white oaks of huge proportions.

In the middle division of Tennessee (Blue Grass region) agriculture has entirely superceded the forest. Here have grown, originally, the finest red cedar, black walnut and yellow poplar. Now farm wood-lots even are strangely absent. In the original forest there were further found white, red, green and blue ash; white, chestnut, burr, cow, yellow, chinquapin and Texan oak; red, black, sugar and ash-leaved maple; white linden, hackberry, honey locust; winged and American elm. On dry hills, fire has played havoc with the forest. Here white and post oak are rapidly removed for cooperage, whilst black, Spanish and scarlet oak, chestnut and black hickories are badly handicapped by fires. Chestnut is usually dying or dead.

The "Black Jack Lands" (marilandica) are large stretches of strongly calcareous soil, stocked with a stunted growth of black jack, extremely monotonous and much less productive than the "Kentucky Barrens." Pinus echinata occurs in island-like groups all over middle Tennessee. Pinus taeda forms a narrow belt along the Alabama line.

In the Cumberland Mountains the limestone coves show, or used to show, a splendid growth of all valuable hardwoods (white, red and chestnut oak; hickory, notably shag bark; black walnut and black cherry; yellow poplar, cucumber, ash and basswood; red cedar on dry cliffs), whilst the sandstone plateaus overlying them exhibit a poor growth, badly burned, of black, Spanish, post and white oaks; further, sourwood, black gum, chestnut and red maple, with occasional tracts of Pinus echinata, virginiana and rigida. Pinus pungens occurs at an altitude of about 3,000 feet and upwards. Good white pine tracts, heavily stocked, are hidden in the backwood coves of the Great Smokies, accompanied on moist and sheltered land by hemlock, or else occur on long, sharp ridges. Spruce and balsams at elevations from 5,000 to 6,000 feet. The hardwoods of the Great Smokies are those of Pisgah forest.

4. Forest ownership: 1,138,000 acres of land are owned by lumber firms. Average stumpage, 3,900 feet b. m. per acre.

5. Use of timber: Logs are worth $2.18 on stump and $6.58 at mill. Logs frequently measured in midst of log. Cedar logs bought by the pound. Lumber centers are Memphis and Nashville. The product of the lumber industry in Tennessee was valued in

| | |
|---|---|
| 1870 | $ 3,400,000 |
| 1880 | 3,700,000 |
| 1890 | 9,100,000 |
| 1900 | 18,100,000 |

The cut consisted of:—

| | |
|---|---|
| Conifers | 82,000,000 feet b. m. |
| Ash | 18,000,000 feet b. m. |
| Poplar | 275,000,000 feet b. m. |
| Red gum | 52,000,000 feet b. m. |
| White oak | 408,000,000 feet b. m. |
| Other hardwoods | 114,000,000 feet b. m. |
| Total | 949,000,000 feet b. m. |

In 1900 Tennessee leads all States in the produced value of staves (181,000,000 staves, worth $2,500,000) and furnishes 17,-

000,000 sets of heading, worth $441,000. Furniture, agricultural and wagon stock are worth $1,245,000.

Leather industry: Value of output, $2,800,000. The tanneries consume 846 cords of hemlock bark and 37,050 cords of oak bark, worth $210,000; further, 58 barrels extract.

Pulp and paper industry: None.

6. Forestry movement: The "Tennessee Forestry Association" was formed two years ago. The Bureau of Forestry has made and published a working plan for a 7,000 acre tract at Sewanee.

7. Laws: Fire laws absolutely ineffective. Arbor Day.

8. Reservations: None.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF TEXAS:

1. Area: Woodlands cover 64,000 square miles or 24% of the total area of State.

2. Physiography: The Rio Grande River on the Mexican line, the Red River along Indian Territory and the Pecos River traversing the extreme western section are the principal streams.

The western prairies are underlaid with limestone; the east is diluvial and alluvial, taversed by the Ozarks and Cross Timbers.

3. Distribution: Deserts in the extreme west (Staked Plains). Undulating prairies destitute of timber in the middle west. Western red cedar found along the canyons. Western high hill ranges, between Pecos and Rio Grande Rivers, show New Mexican flora. Mesquit extends to the desert borders. East of the 96th degree of longitude, the maritime pine belt exhibits splendid forests of long leaf pine, loblolly pine and short leaf pine (echinata). Stumpage of long leaf pine averages heavier than anywhere else, on 2,900,000 acres.

The low flats between the pine hills show impenetrable thickets of hawthorn, holly and magnolia. Bald cypress forms extensive forests in the river bottoms. Pecan, live oak, holly and Carolina poplar show their finest development along the rivers of the east. Osage orange is a common tree in the east. The Cross Timbers are covered with poor post oak and black jack oak woods. These same species extend westward in open groves, ending abruptly where limestone appears. Hackberry said to be found everywhere.

4. Forest ownership: All deserts and outskirts of the Rockies and large forest tracts in the eastern part belong to the State, which, when admitted to the Union in 1845, was allowed to retain its lands and land laws. Federal government owns but a few military reservations.

Lumber companies, in 1900, own 10 billion feet stumpage on 1,671,000 acres. Under the State's general land act of 1895, amended in 1897, the purchase, by individuals, of large tracts belonging to the State is not prohibited.

5. Use of timber: Mesquit and red cedar used for fuel and posts. Cypress said to be of poor quality. Cottonwoods unused so far. The pine belt has been developed rapidly and recently at rising stumpage prices. The output in 1900 was 1,250,000 feet b. m., valued at $16,300,000.

There are 601 saw mills, of $14,000 average investment.

Logs are worth $1.17 on stump and $4.47 at mill.

The eastern pine forests are most valuable for Texas, since they have to supply the constantly growing population of the treeless three-quarters of the State.

The most important industry of Texas is cotton growing.

Stock raising is a close second.

The naval stores industry gradually adopts dangerous proportions, since it injures the prospects for a second growth.

Paper industry attempts to use pinewood in the soda process.

There are nine tanneries, producing about $60,000 worth of leather and using about 390 cords of oak and hemlock bark and 137 barrels of bark extract; balance of material used is gambier.

6. Forestry movement: A State "Forestry and Water Supply Association," formed in 1886, seems inactive.

A forestry commissioner cannot be obtained from the legislature. Remarkable is the necessity for the large Kirby Lumber Co. to practice conservative lumbering, owing to stipulations contained in its mortgage bonds.

7. Laws: No information available.

8. Reservations: None.

9. Irrigation: Irrigation on the enormous cattle ranches of central Texas is practically unknown.

The Mexicans along the Rio Grande and Pecos have irrigated small farms for centuries.

In the east the flooding of rice fields by pumping has recently gained favor.

In 1899, 50,000 acres of farmland were irrigated, yielding crops worth $539,000 from irrigation systems costing $1,028,000.

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FORESTRY CONDITIONS OF UTAH:

1. Area: 13% of the State, or 10,000 square miles, are wooded.

2. Physiography: The western and eastern thirds of the State are barren. The central third is traversed by the Wahsatch Range, which drains eastward into the Colorado River and westward into Salt Lake, Utah Lake and Sevier Lake.

3. Distribution is little known. In the foothills scrub oaks, nut pine, cedar and juniper occur. Best timber (very poor) obtained from the limber white pine. Higher up in the mountains occur blue spruce (Picea pungens), white spruce (Engelmann) and Douglas fir. Yellow pine seems rare, except in the San Pete and San Pitch Ranges. Near Salt Lake the mines have consumed all accessible timber. Cañons are lined with cottonwoods and box elder.

4. Forest ownership: Reserves contain 1,029,760 acres. Large Indian reservation in the northeast called the Uintah Indian reservation. Railroads own alternating sections as usual. Lumber firms own very little.

5. Use: Mine props and fence posts are in chief demand. Coal is cheap. All timber is practically cull; still, log run limber white pine sells at $40 a thousand. Value of timber output, in 1900, only $214,000, less than the figures given in the last three census. Stumpage is reported worth $1.32; logs at mill, $5.31. Eighty-one mills of $1,224 average investment. Two very small tanneries, but no pulp industry.

6. Forestry movement: People and legislature are apprehensive of the necessity of forest protection, as shown by petitions to Congress and the Governor's messages. Shade trees planted in cities and on farms, especially box elder, sycamore, cottonwood and lombardy poplar.

7. Laws: Usual fire laws since 1876. Tax exemption of $500 worth of property for five years for every acre planted in trees, and of $50 for every 100 trees planted on streets or streams.

8. Reservations: The Fish Lake forest reserve (67,840 acres) in the San Pete and San Pitch Range of the Wahsatch Mountains. The Uintah forest reserve (875,520 acres) along the Wyoming line at the head waters of the Green River.

The Payson forest reserve of 86,400 acres lies south of Utah Lake.

The Manti forest reserve of 584,640 acres has been established recently in central Utah; the Logan forest reserve of 182,080 acres in northern Utah.

9. Irrigation: The communal organization of the Mormons has admirably subserved the mutualistic cause of irrigation.

Dry farming, for wheat and barley, is possible only on some high bench lands. Generally speaking, however, irrigation is essential for the raising of forage, grain and fruit crops.

The waters of the northeast, emerging from deep canyons, cut into the mountain sides, are diverted into canals, watering the bench land at the foot of the canyons. Large reservoirs are rare.

The value of products raised on 630,000 acres of irrigated land with the help of irrigation works costing $5,900,000 amounted to $7,500,000 in the census year.

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## FORESTRY CONDITIONS OF VERMONT:

1. Area: 3,900 square miles, or 43% of the State, are under forest.

2. Physiography: The Green Mountains, running north and south through the heart of the State, rise to peaks over 4,000 feet high. Lake Champlain and the Connecticut River are the most important water ways.

3. Distribution: Originally, white pine, hemlock and spruce were imbedded in a forest of hardwoods (beech, maple, yellow birch and some little basswood, butternut, ashes, red, white and burr oak and chestnut oak on red sandstone). Spruce, with bal-

sam, prevails on the ridges. Great bodies of white pine were found on the Connecticut River and in the northwest.

4. Forest ownership: 330 firms own 372,000 acres. 80% of woodlands are attached to farms.

5. Use of timber: White pine is practically exhausted. Quantities of spruce and hemlock are still left. The lumber industry begins to decline slightly. The value of the output of the saw mills was in

| | |
|---|---|
| 1850 | $ 600,000 |
| 1860 | 900,000 |
| 1870 | 3,500,000 |
| 1880 | 3,200,000 |
| 1890 | 6,900,000 |
| 1900 | 6,100,000 |

The cut in 1900 consists of 376,000,000 feet b. m., comprising 261,000,000 feet b. m. spruce; 43,000,000 feet b. m. hemlock; 21,000,000 feet b. m. white pine; 51,000,000 feet b. m. hardwoods.

657 mills report $6,304 as the average investment. Stumpage is worth $2.09; logs at mill cost $5.80.

The maple sugar industry produced, in 1880, 11,000,000 lbs. of sugar.

The leather industry has consumed, in 1900, 4,990 cords of hemlock bark, worth $30,000; 163 bales of gambier, worth $1,200; 100 barrels of extract, worth $1,200. Eight plants produce $186,000 worth of leather.

Paper and pulp industry: 27 plants produce, in 1900, $3,400,000 worth of paper and pulp. There were consumed 31,500 cords of home-grown spruce, worth $172,000; 25,500 cords of Canadian spruce, worth $167,000; 2,262 cords of miscellaneous wood, worth $11,000.

6. Forestry movement: A Forest Commission, appointed in 1882, produced a good report in 1884. No action was taken upon it.

7. Laws: The State pays a premium on forest destruction by exempting the wood lands of saw mill owners for five years from forest taxes. Malicious firing only is punishable.

8. Reservations: None.

9. Irrigation: None.

## FOREST POLICY.

### FORESTRY CONDITIONS OF VIRGINIA:

1. Area: 23,400 square miles, or 58% of State, are woodland.

2. Physiography:—

(a) Mountain section, a belt 60 miles wide along the West Virginia, Kentucky and Tennessee lines, covering two or three tiers of counties and forming 25% of State.

(b) Piedmont plateau, drained in the main by the James River, lying southeast of "a" and forming 50% of State.

(c) Coastal plains, a belt up to 100 miles wide, extending as far as tidewater in the streams. Swamps near the coast, notably the Dismal Swamp. Soil sandy. The plains cover 25% of the State.

3. Distribution: On Virginia soil the northern tree flora meets the southern. The long leaf and taeda pines do not extend further north than Virginia.

Mountain section: The hardwoods of the southern Appalachians (see under North Carolina) prevail here, with some hemlock and white pine. Spruce at high altitudes. The mountain forests were practically untouched in 1880. It is now claimed that certain species, notably chestnut oak, are exhausted.

Piedmont plateau: In the virgin woods, black oak was the prevailing timber; further, white oak, hickories and black gum. Now no virgin forest is left. Vast areas of fields, exhausted by tobacco growing, come up in Jersey pine (virginiana), rigid pine, echinata pine, sumac and sassafras; further, hardwood brush of chestnut, gum and oaks. Little taeda pine.

Coastal plains: The original growing stock, after Michaux, consisted of belts of taeda pine, alternating with belts of echinata. Now a second growth of taeda forms 75% of the growing stock from the seashore to the meridian of Richmond, whilst echinata appears scatteringly. Long leaf pine is commercially unimportant, reaching its northern limit in stunted specimens near Norfolk. The swamps near the coast show cypress, gums and, after Fernow, red cedar.

4. Forest ownership: 418 lumber firms control 402,000 acres of forest, stocked with 4,300 feet b. m. on an average.

5. Use of timber: Main source of lumber is 2d and 3d growth of loblolly pine, sold under the trade name "Virginia pine," which is said to reproduce exceedingly well. Trees 50,

years old are said to yield three logs. Large quantities of loblolly firewood and kindling are shipped to New York. Sumac leaves are gathered for tanning purposes on such a scale that the railroads reported, in 1885, shipments amounting to 10,300 tons—a good indication of the enormous extent of abandoned fields.

Mill investments average $3,934, the number of mills being 1,234. Logs on stump are worth $1.79; at mill, $8.35. The value of the lumber product was in

| | |
|---|---|
| 1850 | $ 1,000,000 |
| 1860 | 2,200,000 |
| 1870 | 2,100,000 |
| 1880 | 3,400,000 |
| 1890 | 5,600,000 |
| 1900 | 12,100,000 |

The figures prove a rapidly increasing production, although the virgin woods have gone for many a decade.

The output in 1900 consisted of:—

| | |
|---|---|
| Hemlock | 1,400,000 feet b. m. |
| Yellow pine | 710,000,000 feet b. m. |
| Yellow poplar | 86,000,000 feet b. m. |
| White oak | 143,000,000 feet b. m. |
| Other hardwoods | 13,000,000 feet b. m. |
| Total | 953,400,000 feet b. m. |

The miscellaneous industries report a product worth $436,-000; the cooperage firms, $587,000; the box concerns, $900,000.

The leather industry is developed on a large scale. 65 tanneries produce $4,717,000 worth of leather and consume 73,646 cords of oak bark, worth $468,000; 420 tons of quebracho, worth $5,400; 6 tons of sumac, worth $233. Little extract is locally used, but large amounts are manufactured for exportation.

The paper and pulp industry works in seven plants and consumes 2,917 cords of spruce, worth $6 per cord; 8,513 cords of poplar, worth $4.50 per cord, and 3,200 cords of miscellaneous wood, worth $2.30 per cord.

6. Forestry movement: Nill. The system of forestry actually practiced on abandoned fields may be classed as "intermittent forestry."

7. Laws: Stock law in many counties. The usual fire laws, existing since 1802, are unobserved.

8. Reservations: None.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF WASHINGTON:

1. Area: 71% of the State is classed as forests (H. Gannett). Of this area, however, much is burned and cut over. Of the original timber, 55% stands intact, 22% is burned and 23% is cut over.

2. Physiography: The southeastern part of the State is practically destitute of timber, excepting the region south of the bend of the Snake River, owing to insufficient rainfall. The Coast Range extends northward into the Olympic Mountains where there is the heaviest rainfall in the United States. The valleys of the Chehalis and Cowlitz Rivers, separating the Coast Range from the Cascade Range, are not densely wooded. Mt. Tacoma (Rainier) has highest elevation in the Cascade Range. Irregular mountain chains, sparsely timbered, running north and south are found in the northeastern part, mostly covered by Colville Indian Reservation.

3. Distribution: The Cascade and Coast Ranges bear the heaviest continuous forest belt in the United States.

The Coast Range is timbered down to seashore, a strip of dunes excepted. Predominating species are red fir (Douglas fir) and red cedar (Thuja plicata). Tideland spruce (Sitka) is said to run only 50 miles inland. Black hemlock forms an almost tropical undergrowth and is the smallest among the giants. Sargent denies fires ever having swept the virgin forest. Pinchot finds cinders below the vegetable litter all over the Olympics.

On the Cascade Range, we must strictly distinguish between west and east slope, owing to great difference in rainfall.

The west slope has at its highest altitudes alpine fir, hemlock, alpine larch (Lyalli) and white bark pine. Descending from the crest we meet Engelmann's spruce, white pine (monticola), lowland fir, amiable fir and noble fir.

Lower down, Alaska cedar (Ch. nootkatensis), western hemlock and western red cedar are met with, and Douglas fir increases in proportion until it forms the prevailing species at lower altitudes. Near the Gulf, tideland spruce occurs.

On the east slope, below the timber line fringed by white bark pine and alpine hemlock, we strike Engelmann's spruce and Douglas fir. Lower down, we enter upon forests of yellow pine (Pinus ponderosa) and groves of lodge pole pine.

The Blue Mountains in the southeast contain yellow pine, Douglas spruce, Engelmann's spruce and lodge pole pine.

The irregular mountain chains in the northeast are said to show timber in the valleys only (?). Yellow pine predominates; in addition, lodge pole pine, Douglas fir and tamarack larch are found; further, Engelmann's spruce, lowland fir, western white pine and red cedar. A tree alder (Alnus Oregona) is remarkable for its size.

The Columbia River and its tributaries are fringed by gigantic broad-leaved species, notably cottonwoods, maples, ashes and willows.

4. Forest ownership: The United States reservations aggregate 7.0 million acres; 0.4 million acres are owned by farmers; lumbermen control the Coast Range and own one-tenth of entire stumpage.

5. Use of timber: Lumber industry is modern. Investment in a saw mill averages $23,500. 24 million staves of cottonwood were manufactured in 1898. In the coniferous forests a yield of 200,000 feet b. m. per acre is not exceptional. 20,000 square miles in one plot are said to average 25,000 feet b. m. per acre. Mining is undeveloped and requires little timber. Clearing of heavy timbered land costs $100 to $200 per acre. Timber claims in 1898 were sold at $10 per acre. The stumpage price after 12th census is 80 cents per 1,000 board feet; logs at the mill are worth $5.14 making logging expenses $4.34.

Washington employs three-fourths of all steam power used in logging in the United States (railroads and donkey engines). The waste in logging is from two-thirds to three-quarters of entire tree. Fires destroy enormous amounts of timber and invariably the hemlock left after lumbering.

During the census year (1900) Washington produced 2.3 billion feet b. m., worth $30,000,000, holding 5th rank among States. There is no paper, pulp and leather industry. (The latter industry consumes only 400 cords of bark, though red fir bark and hemlock bark are rich in tannin.)

Tideland spruce is used mainly for car linings and interior finish; cedar mainly for shingles; hemlock is only beginning to be used at all. Douglas fir is used for all building purposes, trestle bridges and ship building.

The growing stock of timber in Washington consists of

| | |
|---|---|
| Red fir .............. | 90,000,000,000 feet b. m. |
| Spruce .............. | 8,000,000,000 feet b. m. |
| Cedar ............... | 23,000,000,000 feet b. m. |
| Hemlock ............ | 42,000,000,000 feet b. m. |
| Yellow pine ......... | 13,000,000,000 feet b. m. |
| Miscellaneous ...... | 20,000,000,000 feet b. m. |
| Total....... | 196,000,000,000 feet b. m. |

As we are cutting 2.3 billion feet b. m., we are cutting 1.17% of the growing stock per annum.

6. Forestry movement: State association in 1898, composed of lumbermen, securing more stringent fire laws.

7. Laws: Fire laws of 1877 comprehensive and stringent, but uninforced. Law of 1903 makes the land commissioner ex officio "forest firewarden," the county commissioners "deputy firewardens," road supervisors and State land cruisers "forest patrolmen." The firewardens may appoint the cruisers and foremen of lumber firms as "patrolmen at large." Fire laws to be posted; firing of slashings forbidden during dry months. Carelessness in camp fires punishable only if it results in damage to private interests.

8. Reservations: Total area reserved 7,036,000 acres, equal to 15.5% of State. In 1898 there were employed one superintendent, three supervisors and twenty-three rangers.

(a) Olympic forest reserve, 1,466,880 acres. Douglas fir prevails, with hemlock and cedar. Very deep humus. No lumbering, owing to difficulty of transportation. Little chance for farming, grazing, mining.

(b) Washington forest reserve, 3,426,400 acres. Two-thirds of the growing stock (20 billion feet) is formed by hemlock. Little grazing. Timber still inaccessible. Mines beginning to be developed. Reserve is said to include 150,000 acres of agricultural land.

(c) Mt. Rainier forest reserve, 2,027,520 acres, embracing the Mt. Rainier National Park of 207,360 acres, with its unrivalled combination of ice and woodland scenery.

(d) Part (about 104,000 acres) of the Priest River forest reserve.

(e) Blue Mountain forest reserve.

9. Irrigation: Irrigation is profitable on the east side of the Cascades.

Small farms, along the narrow strips of land left between the river and the foot of the cliffs framing the canyons, are found along the Columbia and Snake Rivers. Here, the irrigation of fruit orchards is particularly remunerative, the water being lifted from the river by bucket wheels.

In the Great Bend country it will be necessary to construct reservoirs, storing away the supply furnished by intermittent and uncertain streams.

Washington hops are famous. The seemingly arid soil of the rolling uplands in the east has been found to produce splendid wheat, without irrigation, owing to its remarkable hygroscopic qualities.

The irrigated farms, covering 135,000 acres, produced anno 1899, from irrigation works costing $1,700,000, a crop valued at $2,400,000.

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## FORESTRY CONDITIONS OF WEST VIRGINIA:

1. Area: 18,400 square miles, or 73% of State, are stocked mostly with merchantable timber.

2. Physiography: West Virginia has the poorest shipping facilities of any State in the east. The main rivers (the Big Sandy, Guyandotte, Kanawha and Cheat)—which are not navigable—rapidly traverse a plateau sloping from the crest of the Alleghanies westward to the Ohio River. The Potomac alone, rising in the extreme northeast, finds its way to the east along the Maryland line.

3. Distribution: The hardwoods prevail by far. Echinata pine is found scatteringly on a narrow belt lying half way between the mountains and the Ohio River. Pinus virginiana, rigida and pungens occur on the east slopes and on the poorer soil of the plateau. A few Pinus resinosa, found in the high mountains, are the southernmost representatives of that species.

In the western and northern section the virgin hardwoods have been removed.

Along the upper course of the rivers the primeval forest is frequently intact. Prime walnut, cherry, yellow poplar and white oak occur here in large quantities. At the headwaters of the Green Briar and Cheat Rivers a large and commercially important belt of white pine is found, and, adjoining it to the north, a long belt of splendid spruce. (Spruce stumpage said to average 25,000 feet b. m. to the acre.)

4. Forest ownership: 221 lumber firms own 506,000 acres, of 5,200 feet b. m. average stumpage.

5. Use of timber: Logging and log transportation in the primeval woods of the mountains is extremely difficult, owing to the character of the rivers, the lack of snow and the high expense of railroading in a broken country. 929 mills represent an average investment of $5,700. Logs on stump are worth $2.36; at mill, $6.59. The output of the mills was valued in

| | |
|---|---|
| 1870 | $ 1,500,000 |
| 1880 | 2,400,000 |
| 1890 | 5,500,000 |
| 1900 | 10,600,000 |

The cut in 1900 consisted of:—

| | |
|---|---|
| Hemlock | 91,000,000 feet b. m. |
| Spruce | 94,000,000 feet b. m. |
| Yellow pine | 18,000,000 feet b. m. |
| White pine | 5,000,000 feet b. m. |
| Walnut | 150,000 feet b. m. |
| Poplar | 193,000,000 feet b. m. |
| White oak | 353,000,000 feet b. m. |
| Ash, birch, chestnut | 25,000,000 feet b. m. |

The cooperage materials produced were worth $400,000, and the furniture, wagon, etc., stock, $580,000.

Leather industry: 46 tanneries produce annually $3,200,000 worth of leather and consume 8,445 cords of hemlock bark, worth $50,000; 69,286 cords of chestnut oak bark, worth $305,000; in addition to 394 barrels of bark extract.

Paper and pulp industry: There are 6 mills yielding an output worth $527,000. They consume 5,729 cords of home-grown spruce, for pulp, valued at $30,500; 11,286 cords of home-grown spruce, for sulphite and soda fibre, valued at only $39,100; 1,519 cords of miscellaneous wood, valued at $4,200.

6. Forestry movement: None. Arbor Day failed to be legalized. The West Virginia Agricultural Experiment Station at Morgantown issues valuable bulletins on insect plagues in the forest, written by A. D. Hopkins, the forest insectologist of the United States.

7. Laws: Laws under which unlawful firing is punished are uninforced, although existing on the statute book.

8. Reservations: None.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF WISCONSIN:

1. Area under forest, 31,750 square miles, or 58% of the State.

2. Physiography: Undulating land. Splendid shipping facilities on the shore line of Lakes Superior and Michigan, and on the Mississippi River; helped by a multitude of lakes and floatable rivers. The Wisconsin, Menomonee and St. Croix Rivers are famous for the output of white pine.

3. Distribution: The southwestern section is prairie, intruded by the black oaks and paper birch.

The southeastern section shows the hardwoods (maple, basswood, elm, white and red oak) prevailing, the overtowering white pines having been removed.

The northeast is characterized by hemlock and birch, whilst white and red oak are scarce.

The north shows pineries stocked with white, jack and Norway pines. A large number of swamps produce spruce, balsam, white cedar, tamarack or nothing.

4. Forest ownership: The northern half of the State—the coniferous region proper—is owned in the following proportion:—

| | |
|---|---|
| United States | 5% |
| State and counties | 2% |
| Railroads | 5% |
| Resident settlers | 24% |
| Lumbermen | 50% |
| Outsiders | 14% |

The last census credits the lumbermen with a total forest property of 1,920,000 acres.

5. Use of timber: The growing stock of white pine was estimated in 1880 (by Sargent) at 41 billion feet b. m., and in 1897 (by Roth) at 17 billion feet. Both estimates were found too small. 4.7 billion feet white pine are still owned by lumbermen alone, whilst the annual cut has been from 2 to 3 billion feet since the estimates were made.

The cut of the census year was:—

| | |
|---|---|
| Hemlock ............ | 402,000,000 feet b. m. |
| Norway pine ......... | 94,000,000 feet b. m. |
| White pine ........... | 2,479,000,000 feet b. m. |
| Other conifers ........ | 66,000,000 feet b. m. |
| White oak ............ | 127,000,000 feet b. m. |
| Other hardwoods ..... | 392,000,000 feet b. m. |

The cutting of pines is very close, logs of 4 inches diameter at small end being used. Log drives are said to average frequently only 100 feet b. m. per log. The average investment, in 1,033 saw mills, is $35,959, a figure exceeded only by the Minnesota mills.

Value of products of lumber industry was:—

| | |
|---|---|
| In 1860 ...................... | $ 4,400,000 |
| In 1870 ...................... | 15,100,000 |
| In 1880 ...................... | 17,900,000 |
| In 1890 ...................... | 61,000,000 |
| In 1900 ...................... | 57,600,000 |

which latter figure places Wisconsin in the lead of all States.

The leather industry is important, the value of its products being $20,000,000 per annum. 35 plants use, in the census year, 177,628 cords of hemlock bark, worth $1,070,000; 770 cords of oak bark, worth $8,000; 56 barrels of hemlock bark extract and 1,692 barrels of quebracho extract; 41,726 bales of gambier and 247 tons of sumac.

The paper and pulp industry produces in 47 mills products worth $10,895,000 and consumes 66,300 cords of native spruce for pulp, worth $398,000; 58,659 cords of native spruce for fibre, worth $350,000; 24,754 cords of Canadian spruce, worth $164,000; 1,400 cords of native poplar, worth $12,000, and 60,000 cords of miscellaneous wood (the majority of which is hemlock), worth $210,000.

6. Forestry movement: Forestry commission reports to legislature in 1898. Ernest Bruncken, secretary. (See also XXXI.)

7. Laws: Forest fire warden law of 1898, creating certain county officials ex officio fire wardens.

A law of June 2, 1903, provides for an unpaid "board of forest commissioners" or a "department of forestry." Paid superintendent of State forests acts as secretary of board for records, publications, maps, etc.; acts as "trespass agent" on State forest reserve; acts as chief fire warden of the State; appoints fire wardens in certain counties. Fire wardens and helpers are paid by the towns; but the annual fire expense per township must not exceed $100. Fire notices. Fire reports. Duty of district attorneys to prosecute incendiarism, upon complaint of fire wardens.

All State lands are withdrawn from sale (excepting swamps, farm wood lots, agricultural land and small tracts) and constitute a "State forest reserve." Here possibility of forestry is to be studied by the superintendent; dead and down timber to be disposed of; experiment stations to be formed.

The State may accept unencumbered forest land donated by private persons for reserve purposes. Insufficient appropriation.

Any 40 acres planted with 1,000 pine trees obtain a tax release for fifteen years.

8. Reservations: No federal forest reserves.

The State forest reserves created in 1903 consist of holdings so scattering that protection from fire will be difficult.

9. Irrigation: None.

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## FORESTRY CONDITIONS OF WYOMING:

1. Area: 13% of area of State or 12,500 square miles are said to be wooded. (Underestimate??).

2. Physiography: A broad, high, bare plateau, stretching from the northeast to the southwest into the Uintah Range, occupies one-half the State. Deserts in the southwest (Colorado and Red Deserts). The Yellowstone Rockies occupy the northwestern quarter; the Big Horn Mountains, drained by the Yellowstone River, the central north; the Uintah Mountains come from Utah; the Laramie and Medicine Bow Mountains from Colorado; the Black Hills from South Dakota. The northern moun-

tains are drained by the Yellowstone and Missouri Rivers; the western mountains by the Snake and Colorado Rivers; the southern mountains (Laramie and Medicine Bow Mountains) by the North Platte River.

3. Distribution: Wyoming is the lodgepole pine State. Yellow pine, limber white pine and Engelmann's spruce occupy the moister sections. In the Black Hills, yellow pine prevails, forming valuable forests. Fire has run over all forests. In the Yellowstone Park, lodgepole pine is the prevailing species, of a quality unfit for good timber. Douglas fir and Engelmann's spruce occur at elevations from 7,000 to 10,000 feet.

4. Forest ownership: The United States reserves and parks (aggregating about 10,000,000 acres) cover over two-thirds of the area of woodlands. Only 510 acres of forest are attached to farms, and only 57,000 acres owned by lumbermen.

5. Use: Yellow pine is used for ties and mining timber; lodgepole pine for fencing, fuel, telegraph poles and ties. The other coniferous species are scarcely ever used. From the Big Horn Range and the Laramie Mountains the mining timber is conveyed to the railroads by chutes.

6. Forestry movement: None. Inhabitants are rather opposed to reserves for fear of injury to the growing mining interests. The people outside Wyoming, on the other hand, realize the importance of reserving forested mountain tracts which supply water to the three greatest rivers of the country.

7. Laws: Usual fire laws, but not enforced.

8. Reservations: The Yellowstone National Park contains over 3,000 square miles. It is poorly timbered. Heavy fires prevail in spite of military supervision.

The Yellowstone Park forest reserve contains 1,809,280 acres and lies east of the park.

The Teton forest reserve, of 4,127,360 acres, lies south of the Yellowstone National Park.

The Big Horn forest reserve occupies 1,216,960 acres.

Of the Black Hills forest reserve, the majority of which lies in South Dakota, 429,000 acres are in Wyoming.

The Medicine Bow forest reserve has 420,584 acres.

Features of these reserves are high mountain parks. These parks are very well adapted to stock pasture, notably to sheep grazing. They are, probably, the beds of former lakes.

9. Irrigation: The climate, owing to high altitude, and the soil of Wyoming do not predestine the State favorably for agricultural pursuits. Grazing and mining must remain its staple industries.

In the north, near Sheridan, at an altitude of only 3,700 feet, irrigation has been most successful.

The irrigated farms—mostly hay farms—are of large size.

One of the most interesting irrigation systems tunnels the Laramie Mountains, so as to deliver the waters of the Laramie River to a number of canals on the east side of the mountains.

The irrigation works constructed previous to 1899 cost \$4,000,000 and supply 610,000 acres of farm land, which produce \$2,900,000 worth of crops.

# Forest Policy Preamble

## (I). WHAT IS FORESTRY?

Public opinion identifies the term "forestry" in the prairies with tree-planting; in the lumber states with lumbering; in the east with conservative forestry.

Conservative forestry is lumbering with a view to re-lumbering, or, what is the same thing, lumbering for assets.

The Century Dictionary defines "forestry" as "the art of forming or of cultivating timber, or of the management of growing timber."

Doctor Fernow, in Bulletin No. 5, 1891, says: "Forestry is the art of producing or reproducing certain useful material, or else, to sustain or possibly improve certain useful conditions."

Doctor Schenck wants to give as broad a definition as possible when saying: "Forestry is any treatment, the object of which is woodland." This definition covers prairie planting, lumbering, park forestry, governmental forestry, good and bad forestry. In the case of the investor, the treatment referred to is the developing of undeveloped and the management of developed forestal investments, provided that the owner intends to practice conservative forestry. Whether forestry, in a given locality practiced by the owner of a given forest, is good or bad, depends merely upon personal opinion. Unfortunately, the eastern forestry enthusiasts have continuously condemned destructive forestry (lumbering), in spite of the fact that local conditions — forest fires and taxation — in many a case did not leave the owner any other choice.

Forestry is both science and practice, like engineering, medicine, law, etc. As a science, it is based on other sciences of a more elementary character, which are arranged by Professor Hess, one of the German lights, in the following schedule:

TABLE No. 1.

**Schedule of Sciences Pertaining and Relating to Forestry.**

| A. FUNDAMENTAL SCIENCES: | B. FORESTRY PROPER: | C. AUXILIARY SCIENCES: |
|---|---|---|
| I.—Mathematics. | I.—Private forestry. | I.—Law. |
| *a*: Pure: | *a*: Production: | |
| Arithmetic | Silviculture | |
| Trigonometry | Protection | |
| Analyt. Geometry | Utilization | |
| Different. Calculus | Technology | |
| *b*: Applied: | *b*: Management: | |
| Geodetic survey | Working plans | |
| | Administration | |
| | Mensuration | |
| | Finance | |
| II.—Natural Sciences. | II.—State or governmental forestry | II.—Agriculture. |
| *a*: Explanatory: | *a*: Forest policy: (or politics). | |
| Physics, | | |
| Mechanics, | | |
| Chemistry | *b*: Criminal law | |
| *b*: Descriptive: | | |
| Zoology | | |
| Botany | | |
| Mineralogy | | |
| Geology | | |
| III.—Political economy | | |

## (II.) PURPOSE IN PRIVATE AND IN STATE FORESTRY.

The best forestry is that which complies best with the owner's desire.

This desire may be:

A.—The desire of the private owner:

1.—To make money (from sale of timber, pasture, fruit bark, naval stores, minerals);
(Financial forestry.)

2.—To enjoy sport;
(Game preserves.)

3.—To enjoy and enhance the beauty of the forest;
(Park forestry.)

Obviously, financial forestry holds the leading position with the private owner. Park forestry is mostly practiced by municipalities and wealthy men. In all three cases, we might distinguish between forestry in existing woodlands and forestry on soil now lying bare.

B.—The desire of the commonwealth:

1.—To preserve natural blessings supplied by the forest:
- (a) Water supply (for drink, irrigation, navigation, etc.).
- (b) Health.
- (c) Moderation of temperature.
- (d) Preservation of humidity.
- (e) Rain fall (?).

2.—To prevent calamities:
- (f) Excessive erosion and destructive floods.
- (g) Protection against avalanches, sand shifts, and rough winds.

3.—To preserve national resources:
- (h) Lumber industry (which is second only to agriculture, yielding over a billion dollars' worth of products per annum).
- (i) Productiveness of soil fit for tree growth only.

The desire of the private owner and the desire of the commonwealth are frequently antagonistic the one to the other. The individual owner wants to use the forest to its utmost capacity for his individual purposes; the public, on the other hand, wants the forest left to nature, since the beneficial influences of the forest (a to g) are best obtained from untouched virgin forests. A coppice forest exercises the smallest influence on the natural blessings derivable from the woods.

## (III.) DEFINITION — FOREST POLICY.

Forest policy, as a science, has to deal with the position occupied by the forests and forestry within the economic system of a commonwealth.

Forest policy, as an art or practice, is that part of governmental activity which has the forests and forestry for an object.

### Outline of Following Paragraphs:

1.—Introduction.
- (a) Characteristic features of forestry. (§IV. to §XIII.).
- (b) Direct utility (money made) and indirect utility (losses prevented) of the forest. (§XIV. to §XXII.).

2.—Statistics.
- (a) Consumption. (§XXIII.).
- (b) Production. (§XXIV.).
- (c) Area. (§XXV.).
- (d) World's timber supply. (§XXVI.).

3.—Forest political history and forest political facts. (§XXVII to §XXXII).

4.—Governmental measures regarding private forestry.
   (a) Assisting owner. (§XXXIII to §XXXV.).
   (b) Restricting owner. (§XXXVI.).

5.—Governmental forestry in governmental forests. (§XXXVII to §XXXIX.).

6.—Miscellaneous governmental measures. (§XL to §XLII.).

7.—Forestry in the U. S. (§XLIII f.f.).

# Characteristic Features of Forestry

## (IV.) GENERAL CONSIDERATIONS.

A country without forests is never a prosperous country. The destruction of the forest seems to be, however, more a sign of economic decrepitude than a cause of economic decrepitude.

The industrial system of a country is a quadruped, with commerce for its head, transportation for its body, and agriculture, forestry, mining, and manufacture for its legs. The inter-dependence between these various industries is such as to lay the animal lame if one of its legs is hurt.

Books on forestry frequently state that twenty-five per cent. of a country should be kept under forest cover. Exact figures cannot be given. It may be said, however, that a continental climate requires a larger percentage of forest cover than a maritime climate. In addition, the percentage is affected by the density of population and the configuration of the country.

Forestry as a business has many drawbacks (compare VI.); hence the investor, generally speaking, is averse to embarking in forestry.

In Europe, a paternal and strong-handed government, since olden times, has enforced the preservation of the forests at the expense of the owners, making them responsible for maintaining that forest area which is desired by all. In modern states, such forcible compulsion at the expense of a few will be impossible. Here, two courses are open to a farsighted government, namely: either to offer such financial inducements to its subjects owning forests which will induce them to adopt conservative forestry; or, to buy up forests and forest land, and to undertake forestry on the people's account.

It is doubtful which of these two courses is the cheaper and the preferable one for the commonwealth. No government officer, generally speaking, is a good business man, since he is never allowed to be financially interested in the undertaking, and no business flourishes in the long run in which the leaders are not financially engaged.

On the other hand, if the first course alone be followed, it will still be necessary for the government to employ a staff of officers superintending private owners. Further, the short-lived human being will necessarily engage in short-sighted forestry, and the far-sighted ends at stake in forest policy can be only partially obtained in this way.

A combination of both methods (state ownership plus private forests under the inducement system) seems to Doctor Schenck to be the best means leading towards an adequate area of well-managed forests.

## (V.) ABSOLUTE FOREST LAND.

Forestry is one of the "soil industries." These may be arranged, according to the intensity of labor required, as follows: Ranching;

Silviculture; Hay raising; Production of cereals; Fruit growing; Truck farming.

*Every square foot of national soil should be devoted to that production under which it pays best*; hence forests should never disappear from land on which conservative forestry is the most remunerative use to which the soil may be put. A national platform ought to invariably contain this plank. Land as described is called "absolute forest land."

The following points influence the character of such land:

I. Population:
- (a) Density.
- (b) Energy.

II. Locality:
- (a) 30 per cent slope.
- (b) Rockiness.
- (c) Sandiness.
- (d) Swampiness.
- (e) Frequency of crop failure.

III. Climate:
- (a) Fever districts.
- (b) Rough northern climates and those at high altitudes.
- (c) Excessive rainfall.

IV. Outside causes:
- (a) Transportation facilities.
- (b) Forest fires.
- (c) Taxation.
- (d) Maritime situation.

## (VI.) LAW OF SUPPLY AND DEMAND.

The law of supply and demand does not hold good for forestry:

Wood is the only commodity the production of which covers decades of years. High timber prices will add to the remunerativeness of forestry only at a time when all mature forests are nearly gone. The law of supply and demand, in other words, will begin to work only when the gap in the supply cannot be filled for from fifty to one hundred years. In such a case, it is likely that the gap will never be filled, as it is proven by the history of the Mediterranean countries.

Soil devoid of forests for a long time resists reforestation. The present generation dislikes to carry a heavy burden for the benefit of succeeding generations only. With the legislature, the problem of forest resurrection is never urgent, since its results can be obtained only after many years, and hence laws encouraging it are postponed from session to session.

## (VII.) RATE OF REVENUE.

The rate of revenue in conservative forestry, as in any realty investment, is necessarily a small one. Agriculture in the south, for instance, yields one and one-half per cent. on the farm value only.

The rate of interest in conservative foresty depends largely upon the length of the rotation, decreasing with an increasing length of rotation. It is further influenced by the heaviness of local taxation and the expenses necessary for protection from fire, etc.; which factors, however, are usually of greater influence on short than on long rotations.

The nominal rate of interest trom any investment must be considered as composed of the following factors:

1. An equivalent of true earning power of capital.
2. An equivalent of capital repaid (covering risks taken).
3. A component meant to make up for the declining purchasing power of gold.

The owner of investments other than realties (industrial stock and bonds) cannot help sinking down, gradually, to a lower level of revenue and standing, unless he lays back a considerable fraction of the revenue annually obtained, with a view to rebuilding waning capital.

The purchasing power of forest products does not decline. As a producing machine, the forest remains through all time equally valuable, and its owner remains, at least, equally wealthy. The small rate of revenue obtained from forestal investments compares favorably with a very much larger rate of interest obtained from investments other than realties.

In Saxony, records have been kept since 1816, showing that the forest has paid on the average three per cent. per annum of interest; and that, in addition, the value of the forest has increased, on the annual average, by two per cent. (compound interest)'.

## TABLE SHOWING RELATION BETWEEN LENGTH OF ROTATION AND RATE OF INTEREST.

TABLE No. 2.

| Length of Rotation | Value of Naked Soil | Value of Growing Crop | | Total Value per Acre | Annual Yield per Acre | | Rev. less 20c Tax $ | Gross Interest without Tax | Interest with Tax |
|---|---|---|---|---|---|---|---|---|---|
| 60 yrs | $2. | 1200′ x $4. | $ 4.80 | $ 6.80 | 90′ b.m. at $5.= | $ .45 | .25 | 6.6% | 3.7% |
| 80 yrs | 2. | 3500′ x 4.50 | 15.75 | 17.70 | 150′ b.m. at 6.= | .90 | .70 | 5.1 | 4.0 |
| 100 yrs | 2. | 6180′ x 5. | 30.90 | 32.90 | 185′ b.m. at 7.= | 1.30 | 1.10 | 4.0 | 3.3 |
| 120 yrs | 2. | 9000′ x 5.50 | 49.50 | 51.50 | 205′ b.m. at 8.= | 1.65 | 1.45 | 3.2 | 2.6 |
| 140 yrs | 2. | 11800′ x 6. | 70.80 | 72.80 | 215′ b.m. at 9.= | 1.95 | 1.75 | 2.6 | 2.4 |

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TABLE No. 3.

FIGURES FROM TWELFTH CENSUS ON FOREST LABOR IN THE UNITED STATES:

| Average Number Wage Earners | Total Wages | Capital Invested | Value of Product | No. of Establishm'ts |
|---|---|---|---|---|
| Common hands: 283,260<br>Clerks: 12,530<br>Owners and partners: 43,322 | $104,640,000 | $611,000,000 | $566,000,000 | 33,000 |

Table No. 3 refers only to saw-mills, plaining mills and timber camps of the United States (excluding pulp, stave, fuel production, etc.). Here, the average annual wages of the common wage earner were $369.42.

The "American Lumberman" estimates that the total number of wage earners depending on the forest is not far from 750,000.

## (XII.) TRANSPORTATION IN FORESTRY.

Forest produce is bulky; in other words, its price per pound is low. The distance over which a commodity can be shipped depends upon its value per pound. Hence timber cannot be shipped as far as agricultural produce and must be consumed within a limited radius from the producing point.

Firsts and seconds can be carried over longer distances than common No. 2. Common No. 2 stands a higher freight bill than firewood.

The interdependence between stumpage values and cost of transportation is illustrated by Tables No. 4 and No. 5.

The rank and file of American "Lumber Jacks" penetrate annually deeper and deeper into the forest, bound to cut forty billion feet b. m. per annum.

The average annual increase of logging distance is about one half mile.

Hence the value of all stumpage left at the back of the "Lumber Jack" is increased by as many cents per annum as equals the freight bill for timber of like quality for one half mile.

TABLE No. 4.

Table showing the interdependence between cost of lumber production, including cost of transportation, and value of stumpage, under the following conditions:

1. The cost of production consists of:

First: Cutting—$1.00.

Second: Milling—$1.20 to $4.00.
Third: Hauling—$2.50 to $15.00 per 1,000 feet, b. m.

2. The output of common is supposed to equal that of firsts and seconds.

3. Basal prices per 1,000 feet b. m. lumber:

Cull @ $10; Common @ $15; 1sts and 2ds @ $25.)

| Percentage of Cull: | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|
| Cost of Production: | Stumpage values in dollars per 1000′ b. m. | | | | | | | |
| $ 10. | $7. | $6. | $5. | $4. | $3. | $2. | $1. | $0. |
| 12. | $5. | $4. | $3. | $2. | $1. | $0. | −1 | −2 |
| 14. | $3. | $2. | $1. | $0. | −1 | −2 | −3 | −4 |
| 16. | $1. | $0. | −1 | −2 | −3 | −4 | −5 | −6 |
| 18. | −1 | −2 | −3 | −4 | −5 | −6 | −7 | −8 |

Example: A tree yielding 60 per cent. of cull lumber at an outlay of $16 for lumber production has a negative value of $2 per 1,000 feet b. m.; the owner loses $2 when manufacturing it into lumber, per 1,000 feet, b. m.

TABLE No. 5.

Table showing the influence of hauling distance and form of product on cost of hauling:

(For fairly dry stuff and ordinary roads.)

| Miles Hauled | Small Logs per 1000 ft. | Large Logs per 1000 ft. | Sawed Lumber per 1000 ft. | Split Wood per Cord |
|---|---|---|---|---|
| 1 | $1.00 | $ .75 | $ .35 | $ .35 |
| 2 | 1.75 | 1.10 | .55 | .55 |
| 3 | 2.00 | 1.50 | .70 | .70 |
| 4 | 2.75 | 2.00 | .90 | .90 |
| 6 | 4.25 | 2.75 | 1.40 | 1.40 |
| 9 | 5.75 | 3.75 | 1.90 | 1.90 |

(Hauling price $2.50 per day per team and driver.)

Example: 1,000 feet b. m. of lumber can be hauled over six miles of country roads, on wagons, at an expense of $1.40.

Tables No. 4 and No. 5 illustrate the following laws:

1. Far from the market, a tree fit for lumbering must be a fine tree, yielding a small percentage of cull only.

2. Trees must be converted into lumber or cordwood in close proximity to the forest, if they are of poor quality.

3. Stumpage values decrease rapidly with increasing haulage and increasing output of cull lumber.

## (XIII.) SOIL REQUIREMENTS IN FORESTRY.

Proper forestry does not require fertilizing in the long run. Trees take from the soil smaller percentages of mineral matter than do field crops. (See Table No. 6 from Schlich.)

In addition, trees take mineral food from the lower as well as from the upper strata of soil. Ebermeyer finds that an average forest crop (1 cord of wood or 200 feet b. m. with leaves and branches per acre per annum) takes 54 per cent of the mineral substance required for an ordinary field crop. Of this 54 per cent, however, 46 per cent. (of the whole) is restored to the ground when the leaves fall. Only 8 per cent. is actually imbedded in the wood fibre. After other authorities, the disintegration of the rock keeps pace with the exhaustion of the soil in the case of trees.

### TABLE No. 6.

Table showing pounds of mineral matter required, per acre and year, for crops in field and forest:

| Substance: | $K_2O$ | $C_2O$ | $MgO$ | $P_2O_5$ | $S\ O_2$ | $SiO_2$ |
|---|---|---|---|---|---|---|
| Field Crop: | 78 | 43 | 17 | 28 | 11 | 37 |
| Forest Crop: | 4 | 9 | 2 | 1.4 | 0.4 | 1.6 |

# Useful Functions of the Forest

## (XIV.) UTILITY OF THE FOREST.

The utility of the forest is two-fold:

First: Direct utility, or utility to the owner (money earned).

Second: Indirect utility, or utility to the commonwealth (money saved — losses prevented).

The indirect utility of the forest has been and is in dispute among scientists.

The indirect value of the forest lies in:

(a) The hygienic influence of the forest (§XV.).

(b) The influence of the forest on temperature of soil and air. (§XVI.).

(c) The influence of the forest on moisture conditions (§XVII to §XIX.).

(d) The influence of the forest against the mechanical action of water, wind, avalanches, etc. (§XX.)

Historical data relative to the indirect utility of the forest must be read with care. The advocates of forestry have attributed to the forest the origin of all the good things which Heaven bestows on mankind.

## (XV.) THE HYGIENIC INFLUENCE OF THE FOREST.

The hygienic influence of the forest is explained by the presence of oxygen and the absence of bacteria and dust in the forest air.

Ten acres of forest evaporate, in the course of a day, as much oxygen as is needed for the life of sixteen men for one day.

The air in the forest, however, is no richer in oxygen than the air over the field, with the exception of the edge of the forest and the crown space, where a slight surplus of oxygen is found.

The amount of ozone, however, suspended in the air is much greater in the forest than over the field, and far exceeds the ozone in the city air. The latter fact is apt to be due more to the number of fires in the city than to the absence of trees.

Ten acres of forest evaporate in the course of a year as much oxygen as is required to burn twelve tons of coal (the average family consumption).

The influence of the forest on fever-breeding bacteria is denied by some medical authorities and affirmed by others. At the present moment, it is impossible to see clear, since the ecological conditions of bacterial life are not sufficiently understood.

Ebermeyer attributes the protection which, in his opinion, the forest offers against fevers, to the conditions of the forest soil; the vegetable components of the forest soil containing less matter nutritive to bacterial growth than the soil in the field. The acidity of the humus is antagonistic to pathogenic bacteria. So far, no microbes have ever been found in forest soil; a gramm of soil in the field contains from two to three hundred thousand bacteria.

The absence of dust in the forest is explained by the fact that there is less wind in the forest, and that the carpet on the ground does not allow of dust formation. Bacteria are not carried about by the air, but by the particles of dust suspended in the air.

As a sanitary filter of drinking water, the forest, or rather the soil under the forest, is unexcelled.

## (XVI.) TEMPERATURE.

The air temperature is certainly more influenced by altitude, latitude and proximity of ocean or gulf stream than by the proximity of the forest.

Daily temperature: The forest air is warmer during the night and cooler during the day than the field air.

Mean temperature: In summer the forest air is three degrees cooler than field air; in winter there is scarcely any difference. Shade-bearing species show a greater influence than light-demanding species.

Extreme temperature: The extremes of temperature seem to be considerably influenced by the forest, if publications by Woeickof are correct. After him, the forest lessens the extremes of temperature by about ten degrees. For Germany, the summer extremes in the forests are about seven degrees lower than in the field, the winter extremes about two degrees higher. The radial posts from meteorological stations now established in Europe may throw additional light upon the subject.

Soil temperature is limping behind air temperature by about two months, the difference increasing with increasing depth. (In the soil during May the temperature decreases with depth, in October it increases.)

The soil temperature in the field is almost equal to the air temperature in the field. In the forest, there is a difference of two degrees in favor of the air.

The daily range of temperature in the forest soil is less than in field soil. The summer temperature in field soil is about six degrees higher than in forest soil. In winter there is almost no difference.

The temperature of a tree bole ranges between soil and air temperature. As the temperature of the inner layers of the bole during winter is higher than that of the outer layers, frost cracks are apt to form.

## (XVII.) HUMIDITY.

The humidity of the air depends more on the altitude and the proximity of the ocean than on the presence or absence of forests.

The absolute humidity of forest air, all the year around, is equal to the absolue humidity of field air. The relative humidity (proportion of absolute to possible humidity), however, is less in the field than in the forest — during summer by 10 per cent. and during winter by 3 per cent. and during the year by 6 per cent. — owing to the lower temperature of forest air. As a consequence, radiation is checked during the night and sudden changes of temperature are mitigated in the forest, the forest soil is kept more moist during the summer, and more precipitations, dew and rain occur in the forest.

### (XVIII.) MOISTURE AND PRECIPITATION.

From a theoretical standpoint we should assume that, the humidity in the forest being greater than over the field, more precipitations occur in the forest than in the field.

European experiments relative to the influence of the forest on precipitation are not conclusive. The position of the ombrometer influences the result to a high degree.

As a maker of rainfall, elevation is of largely greater importance than presence of forests. In Europe the higher elevations are usually covered with forests. Experiments showing the truth of the matter can only be made in level country.

### (XIX.) EVAPORATION OF SOIL MOISTURE.

There is a vast difference between the evaporation from field soil and from forest soil, especially if the leaf litter is left on the ground in the forest.

In the latter case, after Ebermeyer, the evaporation from forest soil is only 16 per cent. of the evaporation from field soil. When the litter is removed by rake or fire, the proportion is 38 per cent.

On the other hand, the evaporation from the crowns of the trees is enormous. Forests, it may be said, are the greatest consumers of water. Observations in the Russian steppes prove conclusively that the level of the underground water beneath forests is lower than in the surrounding country. Where there is water, we invariably find forests, in nature,—but not vice versa. Cause and effect should not be mixed.

Evaporation largely depends on the velocity of the wind, which is readily reduced by a shelter belt of forest. Hence, drought in the prairies might be checked by sheltering screens of woodland placed, gridiron-fashion, across country at proper intervals. (Compare Green, p. 28.)

### (XX.) SPRINGS AND RIVERS.

The following facts tend to increase the regularity, if not the amount, of water running off from the forest:

1. The greater porosity of the forest soil increases (proven by German experiments) the permeability of the forest soil.

2. The litter on the ground checks the superficial run-off of water on the slopes.

3. The litter and debris on the ground act as a sponge and cause precipitations to trickle through gradually.

4. The melting of the snow is retarded under a dense forest cover.

5. The evaporation from the soil in summer is reduced.

The points 1, 2 and 3 change rapid surface drainage into slow underground drainage.

On the other hand, as stated in the preceeding paragraph, trees lower the level of the ground water.

Afforestation in the European Alps proves conclusively that there is an influence of the forests on the regularity of stream flow.

The fact that inundations are now more frequent in this country than they were twenty years ago must be explained, to a high degree, by river courses cleaned for the benefit of navigation, by bottom land cleared and by swamps drained for the benefit of agriculture.

Agriculture is certainly more responsible for the destruction of its own crops in the lowlands, by freshets and inundations, than destructive forestry in the mountains. Here, after Dr. C. A. Schenck, the man who burns the litter on the ground is to blame, and not the lumbermen who cut the trees; for it is the litter on the ground — more than the tree — that regulates the flow of our mountain streams.

## (XXI.) MECHANICAL INFLUENCE OF THE FOREST.

The mechanical influence of the forest is shown by the prevention of excessive erosion on forest-covered slopes. Previous to afforestation of gullied slopes, breastworks should be made beginning at the upper edge of the gullies. When the soil is quieted down, planting may begin.

Forest plantations may also be used to prevent the inland movement of sand dunes along the seashore. Dunes must be first fixed and raised as high as possible by planting sand grasses on the leeward side; afforestation (with pines) may set in thereafter.

Forests are also recommended as remedies for avalanches. The formation of avalanches must be prevented at the "point of rupture." This point, however, lies frequently above timber line. Stone walls are certainly more efficient at such points than plantations of trees. Forests further offer protection against air currents. In the prairies, shelter belts of forests prevent blizzards from laying wheat lands bare of snow and facilitate the wintering of stock.

The influence of the forest on hail storms is limited, perhaps imaginary.

## (XXII.) DIRECT UTILITY OF THE FOREST.

The variety of raw products furnished by the forests is very considerable. We may distinguish between "principal products" and "minor products." The former comprise wood and timber only; the latter include all other raw material obtained in the forest, for instance, naval stores, tanbark, Florida moss, rubber, guttapercha, fish and game, minerals, pasture, etc.

The value of minor products formed by or found in the forest frequently far exceeds the value of wood and timber annually produced — especially in remote backwoods.

# Forest Statistics

## (XXIII.) STATISTICS OF CONSUMPTION.

The consumption of timber in a country depends on the habits of its people, the price of timber and the price of stone and brick, of iron and steel; the form of settlement — whether scattered or concentrated into cities; the climate; the stage of civilization; the prevailing prosperity.

Per capita per annum, the consumption of timber in the United States is 600 feet, b. m.; in Germany, 100 feet, b. m.

The consumption of firewood depends on the climate, the price of coal, kerosene, and on the prevailing prosperity.

Per capita per anum the consumption of firewood in the United States is 2.8 cords; in Germany, 0.3 cord.

TABLE No. 7.

**Data Relative to Lumber Consumption in the United States During the Year 1900.**

| | | |
|---|---|---|
| Lumber from conifers | 26.15 | billion feet, b. m. |
| Lumber from hardwoods | 8.63 | " " " |
| Shingles | 12.10 | " pieces. |
| Laths | 2.52 | " " |
| Staves | 1.66 | " " |
| Hoops | 0.44 | " " |
| Heading | 0.12 | " sets. |
| Carriages and wagons | 0.08 | billion feet, b. m. |
| Agricultural implements | 0.03 | " " " |
| Furniture | 0.11 | " " " |
| Bobbin and spools | 0.04 | " " " |
| Pickets and paving | 0.04 | " " " |
| Railroad ties | 0.06 | pieces. |
| Telegraph and telephone poles | 0.12 | " |

TABLE No. 8.

**Showing Lumber Consumption of Various Conifers, with Stumpage Prices, Year 1900.**

| | CONSUMPTION IN FT. B.M. | STUMPAGE PER M. FT. B.M. |
|---|---|---|
| Yellow pine | 10.6 billion. | $ .80 to $1.60 |
| White pine | 7.5 " | 1.50 to 4.00 |
| Hemlock | 3.4 " | 2.00 to 3.00 |
| Redwood | 0.4 " | 1.00 |
| Spruce (lumber) | 1.4 " | .70 to 3.00 |
| Cypress | 0.5 " | .75 to 2.46 |
| Cedar | 0.2 " | .75 to 2.00 |
| Norway pine | 0.3 " | 2.76 to 2.97 |
| Red fir, Oregon pine | 1.7 " | .60 to 1.06 |
| Sugar pine | 0.5 " | .60 to 1.71 |
| Tamarack | 0.05 " | 1.00 |
| All others | 0.01 " | |

Note.—The higher prices are usually for the east, the lower for the west. In sugar pine, the higher price is for the Cascade mountains, the lower for the Sierras, which are farther from the ocean. Under "All others" are included various species on the Pacific coast.

TABLE No. 9.

**Showing Lumber Consumption of Various Hardwoods, with Stumpage Prices, Year 1900.**

| | CONSUMPTION IN FT. B.M. | STUMPAGE PER M. FT. B.M. |
|---|---|---|
| Ash | 0.3 billion. | $2.27 to $3.10 |
| Birch | 0.1 " | |
| Chestnut | 0.1 " | 2.71 |
| Cottonwood | 0.4 " | 1.15 to 2.24 |
| Elm | 0.5 " | 2.40 to 3.40 |
| Gum, sweet | 0.3 " | 1.68 (high) |
| Hickory | 0.1 " | |
| Linden (basswood) | 0.3 " | 1.50 (low) |
| Maple | 0.6 " | |
| Oak | 4.4 " | 1.00 to 5.40 |
| Yellow poplar | 1.1 " | 2.00 to 3.00 |
| All others | 0.3 " | |

## (XXIV.) STATISTICS OF PRODUCTION.

The production of forests may be considered in two ways:

(A) As increment production, or the amount of wood fibre actually formed in the forest.

(B) As commercial production, or the amount of timber and wood taken from the forest.

(a) Increment production, as regards timber, is almost at a standstill in the United States. In the primeval forest, the death rate equals the production; and in cut-over forests, the production of timber proper is very small. Since large amounts of fine timber are annually destroyed by fire, it may be said that the actual production of timber in the United States is nil. On the other hand, the production of wood fit for fuel, etc., is very large on cut-over land not too heavily burned. It is impossible to give accurate figures; 200,000,000 cords, perhaps, is a safe estimate of fuel wood annually produced in the United States.

The increment or rate of production of timber in any given forest depends on:

(1) Species grown, conifers generally producing more than hardwoods.

(2) Climate and soil.

(3) Condition of the growing stock.

In the German forests the average annual production of timber per acre is 90 feet, b. m.

The fuel production per acre amounts to two-thirds of a cord.

(b) The commercial production of timber in the United States slightly exceeds the consumption; the produced surplus, amounting to about one billion feet, b. m., is exported.

In Germany, the increment production falls short, by about 3½ billion feet, b. m., from covering the home requirements for commercial production. Germany could easily supply all her commercial demands, without timber imports, for a long number of years, if she would reduce her forest capital as unscrupulously as the United States.

TABLE No. 10.

**Showing Shift of Center of Commercial Timber Production in the United States since 1850.**

| Census | Northern States | Lake States | Southern States | Pacific States |
|---|---|---|---|---|
| 1850 | 54.5% | 6.4.. | 13.8.. | 3.9.. |
| 1860 | 36.2.. | 13.6.. | 16.5.. | 6.2.. |
| 1870 | 36.8.. | 24.4.. | 9.4.. | 3.6.. |
| 1880 | 24.8.. | 33.4.. | 11.9.. | 3.5.. |
| 1890 | 18.4.. | 36.3.. | 15.9.. | 7.3.. |
| 1900 | 16.0.. | 27 4.. | 25.2.. | 9.6.. |

TABLE No. II.

**Showing Value of Commercial Timber Product of the United States since 1850.**

| Census. | Value of Products. |
|---|---|
| 1850 | $ 60,400,000.00 |
| 1860 | 96,200,000.00 |
| 1870 | 210,100,000.00 |
| 1880 | 233,300,000.00 |
| 1890 | 437,900,000.00 |
| 1900 | 566,600,000.00 |

## (XXV.) FOREST AREA.

(a) Requirements of area for direct utility (timber and fuel supply.)

Generally speaking, countries having over twenty per cent. of woodlands have enough forest area to supply their lumber industries and their firewood consumption, if such area is properly stocked and conservatively used.

To supply the present consumption of the United States the present forest area, ceteris paribus, seems more than sufficient. Seven hundred million acres, the present forest area, should yield, at the rate of 90 feet board measure per acre, sixty-three billion feet board measure per annum.

Verily, if this enormous stretch of forest were properly stocked and conservatively managed, the lumber consumption of the United States, now about forty-five billion feet b. m., could never exceed, in times to come, the possible increment production of the forest area at hand.

In Dr. C. A. Schenck's opinion, the lumber consumption in this country has reached its highest pitch anno 1900.

(b) Requirements of area for indirect utility (supply of water, health, etc.).

In the deserts, prairies, and prairie borders, there is not and never will be sufficient woodland to influence favorably the general conditions of the commonwealth. In the Rocky and in the Appalachian mountains, the forest area is ample, provided that it be kept stocked with trees, and that the litter be left on the ground. In all other sections, the forest area is more than sufficient for the people's welfare, the vicinity of the cities excepted.

As regards ownership, after Dr. Fernow, 30 per cent. of our woodlands are attached to farms. After Dr. West (Agricultural Year Book, 1898) 36 per cent. of the woodlands of the country are still owned by the United States. The balance of 34 per cent. seems left in the hands of the various States, or is controlled by lumbermen, railroads, investors and speculators.

TABLE No. 12.

**Percentage of Forest Area by States.**

| STATES HAVING OVER 70% | STATES HAVING OVER 60% | STATES HAVING OVER 50% | STATES HAVING OVER 40% |
|---|---|---|---|
| Maine | Michigan | New Hampshire | Vermont |
| West Virginia | Minnesota | Massachusetts | New Jersey |
| North Carolina | South Carolina | Pennsylvania | Maryland |
| Georgia | Mississippi | Virginia | Idaho |
| Alabama | Louisiana | Kentucky | |
| Arkansas (84%) | Tennessee | Wisconsin | |
| Washington | Indian Territory | Oregon | |
| | Florida | Missouri | |

| STATES HAVING OVER 30% | STATES HAVING OVER 20% | STATES HAVING OVER 10% | STATES HAVING UNDER 10% |
|---|---|---|---|
| New York | D. of Columbia | Illinois | Dakota, North and South |
| Delaware | Ohio | Iowa | Nebraska |
| Connecticut | Texas | Oklahoma | Kansas |
| Colorado | Montana | Wyoming | Nevada |
| Rhode Island | Arizona | New Mexico | |
| | California | Utah | |
| | Indiana | | |

TABLE No. 13.

**Data Relative to Present Standing Stock (Timber—Stumpage).**
(After B. E. Fernow.)

| | FEET B. M. |
|---|---|
| Southern States | 700,000,000,000 |
| Northern States | 500,000,000,000 |
| Pacific Coast | 1,000,000,000,000 |
| Rocky Mountains | 100,000,000,000 |
| Total forest wealth | 2,300,000,000,000 |

This forest wealth is sufficient to supply the commercial production of the United States for fifty years, at the present rate of consumption.

## (XXVI.) THE WORLD'S TIMBER SUPPLY.

European experts, notably Dr. Wm. Schlich, predict a timber famine — more especially of softwoods — in view of the fact that Norway's and Austria-Hungary's surplus production is nearing an end; that the world's population, and hence its timber demands, increase rapidly. Russia, which Prof. Endres expects to fill the gap in the waning supply, will cease to be a timber exporter, after M. Melard, from the year 1950 on.

Enormous tracts of untouched woodlands (coniferous) are still found in Russia (516,000,000 acres of woodland, 60 per cent. of which is crown forest); in Siberia (763,000,000 acres of crown forest have been surveyed so far — and surveying is not completed); in Canada, which commands a gigantic unknown acreage of woodlands in its western vastness.

There seems acreage enough! As a matter of fact, however, the stand of timber, per acre, in these cold countries, is very poor; a large share of the woodlands consists of unproductive swamps; the transportation of timber must be by rail, the rivers generally emptying northward into the ice-sea; no wonder, then, that the commercial timber production in Russia, Siberia, and Canada will encounter excessively high expenses.

There is approaching, undoubtedly, a famine of good, cheap and soft lumber.

TABLE No. 14.

**Showing Excess Imports and Excess Exports of Timber for Various Countries in Million (long) Tons.**

| COUNTRIES | EXCESS IMPORTS | EXCESS EXPORTS |
|---|---|---|
| United Kingdoms | 10.0 | |
| Germany | 4.6 | |
| France | 1.2 | |
| Norway | | 1.1 |
| Sweden | | 4.5 |
| Austria | | 3.7 |
| Russia | | 5.9 |
| United States | | 1.0 |
| Canada | | 2.1 |

# History and Facts of Forest Policy

## (XXVII.) UNITED STATES FOREST POLITICAL HISTORY.

### First Period, up to 1800 — "Early Regulations."

Exeter (now New Hampshire) regulates oak cutting........ 1640

Pennsylvania ordains that "The grantee must keep the one-sixth part of land (granted in Pennsylvania) in forest.. 1682

New Hampshire fines the cutting of mast trees on ungranted land and appoints the first forest official, "Surveyor General of Forests"................................ 1708

All thirteen States adopt forest fire laws, modeled after European patterns but without European police............ 1780

Travels of the two Micheaux and the publication of their "North American Sylva"..............................1785-1805

### Second Period, 1800-1870 — "Stagnation of Forest Policy."

Congress appropriates $200,000 for the purchase of naval timber and timber lands on some of the Georgia coast islands ........................................... 1799

Congress authorizes the President to reserve live oak and cedar tracts in the Louisiana Purchase for naval use.... 1817

(About 250,000 acres thus reserved in the succeeding years.)

Congress authorizes the President to use land and naval forces for timber protection, in parks only (still in use).. 1822

Congress appropriates $20,000 for silvicultural experiments with live oak........................................ 1827

Congressional act punishing persons "cutting or destroying live oak, red cedar, or other trees growing on U. S. land," 1831

First Forestal Census, reporting 31,000 saw-mills, averaging $400 value of annual output (prices higher than now).... 1840

Great development of the lumber industries by the rapid opening of the Lake States, and the building of railroads 1865

Appearance of scattering articles in agricultural reports and magazines in regard to indirect utility of the forest (mostly translated from European works).............1860-1870

### Third Period, 1870-1902 — "Infancy of Forest Policy."

First attempt to canvass the forest resources of the U. S. by Prof. F. W. Brewer (ninth census).................... 1870

First publication on forest policy by Dr. J. A. Warder, and by G. P. Marsh, on "The Earth as Modified by Human Action" ................................. ........ 1873

American Society for the Advancement of Science memorializes Congress and the State legislatures to "promote cultivation of timber and to preserve the forests" and recommends proper legislation towards that end....... 1873

Timber culture act, making it possible to acquire a quarter section of prairie land by planting 40 (or less in later years) acres in trees. Up to 1889, out of thirty million acres entered under this law, only 779,000 acres were granted. Law was repealed in 1891.................... 1873

All prairie States, also Wisconsin, Minnesota, New York and Connecticut, begin to grant bounties or tax release on forest planting ....................................1870-1877

Congress appropriates $2,000 for a forestal agency in the Department of Agriculture. Duties of the agent: To gather statistics and to furnish information. Dr. F. B. Hough appointed. Three voluminous reports.......... 1876

Agency is advanced to the rank of a division.............. 1881

Formation of the "American Forestry Congress," styled thereafter "American Forestry Association," at Cincinnati, by the influence of Baron von Steuben........ 1882

Decade of "Paper Work" by State commissions..........1880-1890

Monumental report on forestry by C. S. Sargent in Tenth Census .................................................. 1880

M. H. Eggleston succeeds Hough as Chief of the Division of Forestry ............................................ 1883

Division of Forestry made an integral part of the Department of Agriculture. Dr. B. E. Fernow, Secretary of the American Forestry Association, succeeds Eggleston as Chief. Small appropriations, never exceeding $30,000.. 1886

Valuable reports (especially on Timber Physics, Sylvan Nomenclature, Southern Pines, Sheep Grazing), whilst no practical work and no practical results were possible. The public mind, however, fully prepared, by continuous agitation, for future work.

Congress authorizes the President to create forest reserves by proclamation........................... 1891

Gifford Pinchot appointed Chief of Division............... 1898

Appropriations increased rapidly to almost $300,000. Practical work begun on a large scale. Gradual reconciliation between lumbering interests and forestry.

Division elevated to rank of Bureau, with five divisions (Forest Management, Forest Investigations, Forest Extension, Forest Products, and Records) Excellent reports of practical value.......................... 1901

## (XXVIII.) THE PRESENT STATUS OF FEDERAL LANDS OF THE UNITED STATES.

The United States government still owns within its continental borders, exclusive of Alaska, 677,000,000 acres—(= 1-3 of total area) —of land, 224,000,000 acres of which are unsurveyed. This land is composed as follows:

| | | |
|---|---|---|
| Reserves | | 151,000,000 acres |
| Military | 800,000 acres | |
| Indian | 80,000,000 " | |
| Forest | 60,000,000 " | |
| National parks | 4,000,000 " | |
| Reservoir sites | 200,000 " | |
| Miscellaneous | 6,000,000 " | |
| Grazing land | | 332,000,000 acres |
| Unreserved woodland | | 124,000,000 " |
| Deserts | | 70,000,000 " |

The unappropriated land, everywhere, is naturally less adapted to agriculture than used to be the case some ten or twenty years ago, the best land having already been taken.

After F. H. Newell, Chief Hydrographer of the United States, and Major Powell, former Chief of the Geological Survey, not over one hundred million acres of the semi-arid region can ever be improved by irrigation.

The percentage of vacant land in the various western States is as follows:

Over 90 per cent—Nevada.
Over 80 per cent—Idaho, Wyoming, Utah.
Over 70 per cent—Montana, Arizona.
Over 60 per cent—Colorado, New Mexico.
Over 50 per cent—California, Oregon.
Over 40 per cent—Washington, North Dakota.
Over 30 per cent—South Dakota, Oklahoma.
Over 20 per cent—Nebraska.

The sale to private parties of vacant land belonging to the United States takes place through the General Land Office of the Department of the Interior, under the following laws:

First: The Homestead law, which provides that any citizen of the United States may acquire one hundred and sixty acres of land of the United States, not otherwise occupied or reserved, by filing an affidavit of honest intention with the local land agent, paying certain fees, and either residing on the land for five years, or else residing on the land six (viz. fourteen) months and paying for the value of the land at the minimum rate of one dollar and twenty-five cents per acre. (Commutation clause.) In 1902, 14,052,351 acres were thus disposed of.

In the State of Missouri public lands are sold privately at the rate of one dollar and twenty-five cents per acre away from the railroads, and in alternate sections along the railroads at two dollars and fifty cents per acre.

In Oklahoma, homesteaders settling under the homestead law must pay from one dollar to two dollars and fifty cents, and in Minnesota, on the former Chippewa reservation, one dollar and twenty-five cents extra per acre.

A number of special laws facilitate homesteading for certain applicants and in certain localities.

Second: Isolated tracts of vacant land are sold upon request of parties interested, after advertising in the local papers, in tracts not exceeding one hundred and sixty acres in extent, at public auction. Minimum price must be one dollar and twenty-five cents. These are the only auction sales of public lands. Sales in 1902 aggregate 80,841 acres.

Third: The Timber and Stone Act, permitting every citizen or prospective citizen to acquire one hundred and sixty acres of land, unfit for either agriculture or mining, at a price of two dollars and fifty cents per acre.

Sales in 1902, under this act, comprise 545,254 acres.

Fourth: The Desert Land Act, meant to encourage irrigation and permitting the disposal of public land in quantities not exceeding 320 acres. Grantee is not required to reside on the land granted. Woodland can scarcely be acquired under this act.

Sales in 1902 comprise 929,230 acres.

Fifth: The Indian land laws provide that Indian lands ceded to the United States, if agricultural or irrigable, must be opened to homestead entry.

In 1902, 116,150 acres of Indian lands thus ceded were sold at $2.50 per acre.

Indian allotments, the President alotting to each member of a tribe from 40 to 160 acres according to its age, are held in trust by the United States for the allottees, to be conveyed in fee, after the lapse of 25 years. Indian Territory and some Indian reservations (New York, Nebraska) are exempted from this rule.

Indian allotments made in 1902 amounted to 31,190 acres.

Sixth: The Mining laws distinguish between —

(1) Placer mines, which are open to entry in tracts not exceeding 160 acres, obtainable at $2.50 per acre.

(2) Lode mines, which are patented to the claimant in tracts not exceeding about twenty acres, on payment of $5 per acre.

In both cases, claimant must have invested on his claim $500 for labor and improvements before issue of patent.

In the Lake States, further in Missouri, Kansas, Alabama, mineral land is either sold at public auction or opened to entry like agricultural land.

The mineral lands sold by the United States in 1902 cover 97,658 acres.

The so-called "State Selections" amounted, in 1902, to 1,458,371 acres; the "Railroad Selections" to 1,931,905 acres; the "Swampland Patents" to 88,639 acres.

In toto, during 1902, 19,488,535 acres were appropriated.

The cash sales comprised in this figure aggregate only 1, 757,593 acres of land. On an average the United States dispose annually of 15,000,000 acres of land.

The Hansbrough Bill, in November, 1903, considered by the Senate of the United States, attempts to annull the provisions of the timber and stone act and to withdraw all absolute forest land from entry, containing the following provisions:

(I.) TIMBER AND STONE.

1. Method of sale is auction through Secretary of the Interior, after public advertising.

2. The acreage, kind and quality of stumpage offered, the rules of logging, further, the period of removal, is left to the discretion of the Secretary.

3. The approved highest bidder is not allowed to assign his purchase rights thereafter.

(II.) ENTRY:

1. Land of absolutely forestal character is withdrawn from homestead entry, lieu-land or State selection, public sale, etc.

2. The federal government hereafter *retains the fee-simple in all absolute forest land.*

3. Only actually agricultural land, non-mineral and non-timbered, can be homesteaded or entered under desert land act.

(III.) LIEULAND:

Lieu selections of owners or claimants of interior holdings in forest reserves are restricted to vacant, non-mineral, surveyed land not chiefly valuable for its timber.

Vacant timber land of the United States, not reserved nor in parks, is utilized as follows:

1. General Land Office delegates Special Agents for protection, legal proceedings, examinations, reports, etc. In 1902, only 63 agents were employed on the vacant public lands, a staff entirely inadequate to enforce the laws.

2. Homestead (and preemption) claimants, like tenants, may cut timber to clear land and to build houses; on the other hand, no timber must be sold, until patent is issued.

3. Secretary of Interior may authorize Indians to sell dead and down timber on Indian reservations.

4. Residents of the Rocky Mountain States may cut, for individual purposes and not for sale, timber of 7 inches and over diameter stocking on mineral land. (Mesquit, however, can be thus cut for sale.) Where land is non-mineral, residents have no chance to cut or purchase timber, and are forced to trespass on public lands.

5. Purchase of absolute forest land, of non-mineral character, under provisions of "Timber and Stone Act," of 1878, is open to bona fide applicants, in 160-acre lots, at $2.50 per acre. This is practically the only public land law, under which the lumberman, in 1902, can increase his supplies of raw material.

6. Railroad and telegraph companies are privileged to obtain timber, for construction purposes, from adjoining vacant land, within ordinary hauling distance.

The Denver and Rio Grande Railroad is allowed repair timber as well as construction timber.

7. Timber from public lands must be consumed within the State producing it.

8. Unlimited stock pasture on vacant public timber land — provided that pastures are unfenced.

9. Boxing of timber is forbidden.

10. Heavy fines on firing woods, or endangering woods by fire.

## (XXIX.) HISTORY OF U. S. FOREST RESERVES.

United States Forest Reserves are land reserved from entry under any of the existing laws of entry. (See §XXVIII.) They are meant for public use, through the utilization of their waters, their lumber, their mines, their forage grounds; and are established by Presidential proclamation, under the law approved March 3, 1891.

National Parks, on the other hand, can be established only by Act of Congress, and are not intended to be utilized. The United States Army furnishes protection for the National Parks, but not for the Forest Reserves.

The first reserves were established in 1891 under the auspices of the then Secretary of the Interior, John W. Noble. The reserves comprised, 1893, some eighteen million acres.

In 1896 the National Academy of Sciences, upon the request of the Secretary of the Interior, appointed a commission to report on a rational forest policy for the forested lands of the U. S. This commission was headed by Charles S. Sargent, who appointed Gifford Pinchot Secretary of the Commission. After traversing the west on a flying tour, the commission advised the establishment of twenty-one million acres of additional reserves, situated in Washington, Oregon, California, Wyoming, Montana, Idaho, Utah, South Dakota.

Public opinion in the Pacific States, however, forced the Senate to suspend the proclamation of President Cleveland, issued February 22nd, 1897, by which these twenty-one million acres of reserves were set aside, until March 1898. In the meantime, a great change of public opinion in the west took place, the people becoming convinced that irrigation without forest reserves is impossible. In addition, the General Land Office consented to modify the regulations governing the use of the reserves, permitting sheep and cattle pasture to a limited degree, thus removing one of the greatest causes for complaint. The reserves are now established and begin to find strong support amongst their former opponents.

Noteworthy it seems that the lumbermen have never objected to the establishment of Forest Reserves in the west.

Presidents McKinley and Roosevelt have created additional reserves, raising the aggregate, in 1902, to 60,175,765 acres comprised in 54 reserves. (This is twice the area of Pennsylvania, and equal to 2½% of the entire area of the United States, inclusive of Alaska.)

Agricultural and mineral land included, through error, within the proclaimed limits of a forest reserve may be restored to the possibility of entry by the President of the United States.

Reserved lands, proven to be "mineral" remain subject to entry, without requiring such restorative act.

The General Land Office, on the basis of the Sundry Civil Appropriation Bill of June 4, 1897, issues, from time to time, rules and regulations governing the use and the administration of the forest reserves.

TABLE NO. 15.

THE FOREST RESERVES ESTABLISHED ARE:

| States and Territories. | Name of reserve. | Present estimated area, in acres. |
|---|---|---|
| Alaska | The Afognak Forest and Fish Culture Reserve, | 403,640 |
| | The Alexander Archipelago Forest Reserve | 4,506,240 |
| Arizona | The Grand Canyon Forest Reserve, | 1,851,520 |
| | The San Francisco Mountains Forest Reserve, | 1,975,310 |
| | The Black Mesa Forest Reserve | 4,658,880 |
| | The Prescott Forest Reserve, | 423,680 |
| | The Santa Rita Forest Reserve, | 387,300 |
| | The Santa Catalina Forest Reserve, | 155,520 |
| | The Mount Graham Forest Reserve, | 118,600 |
| | The Chiricahua Forest Reserve, | 169,600 |
| California | The San Gabriel Timber Land Reserve, | 555,520 |
| | The Sierra Forest Reserve, | 4,096,000 |
| | The San Bernardino Forest Reserve, | 737,280 |
| | The Trabuco Canyon Forest Reserve, | 109,920 |
| | The Stanislaus Forest Reserve, | 691,200 |
| | The San Jacinto Forest Reserve, | 668,160 |
| | The Pine Mountain and Zaca Lake Forest Reserve, | 1,644,594 |
| | The Lake Tahoe Forest Reserve, | 136,335 |
| | The Santa Ynez Forest Reserve, | 145,000 |
| Colorado | The White River Forest Reserve, | 1,129,920 |
| | The Pikes Peak Timber Land Reserve, | 184,320 |
| | The Plum Creek Timber Land Reserve, | 179,200 |
| | The South Platte Forest Reserve, | 683,520 |
| | The Battlement Mesa Forest Reserve, | 858,240 |

| | | |
|---|---|---|
| | The San Isabel Forest Reserve,........... | 77,980 |
| Idaho and Montana | The Bitter Root Forest Reserve,.......... | 4,147,200 |
| Idaho and Washington | The Priest Forest Reserve,............... | 645,120 |
| Montana | The Flathead Forest Reserve,............ | 1,382,400 |
| | The Lewis and Clarke Forest Reserve, (even sections), ............................ | 2,926,080 |
| | The Gallatin Forest Reserve,............. | 40,320 |
| | The Little Belt Mountains Forest Reserve, | 501,000 |
| | The Madison Forest Reserve,............ | 736,000 |
| | The Absaroka Forest Reserve,........... | 1,311,600 |
| Nebraska | The Dismal River Forest Reserve,........ | 85,123 |
| | The Niobrara Forest Reserve,........... | 123,779 |
| New Mexico | The Pecos River Forest Reserve,......... | 431,040 |
| | The Gila River Forest Reserve,........... | 2,327,040 |
| | The Lincoln Forest Reserve,............. | 500,000 |
| Oklahoma | The Wichita Forest Reserve, ............ | 57,120 |
| Oregon | The Bull Run Timber Land Reserve,...... | 142,080 |
| | The Cascade Range Forest Reserve,...... | 4,436,120 |
| | The Ashland Forest Reserve,............. | 18,560 |
| South Dakota and Wyoming | The Black Hills Forest Reserve,.......... | 1,211,680 |
| Utah | The Uintah Forest Reserve.............. | 875,520 |
| | The Fish Lake Forest Reserve,.......... | 67,840 |
| | The Payson Forest Reserve,............. | 86,400 |
| Washington | The Washington Forest Reserve,......... | 3,426,400 |
| | The Olympic Forest Reserve,............ | 1,466,880 |
| | The Mount Rainier Forest Reserve,....... | 2,027,520 |
| Wyoming | The Yellowstone Forest Reserve,......... | 1,834,240 |
| | The Big Horn Forest Reserve,........... | 1,216,960 |
| | The Teton Forest Reserve,.............. | 4,127,360 |
| | The Crow Creek Forest Reserve,.......... | 56,320 |
| | The Medicine Bow Forest Reserve,....... | 420,584 |

There are, at present, no reserves east of the Mississippi.

The Minnesota National Forest Reserve, when completed, will contain about 225,000 acres.

In the Philippine Islands, the United States fell heir to about 47,000,000 acres of tropical woodland, now placed in charge of a Bureau headed by Capt. G. P. Ahern.

## (XXX.) HISTORY OF STATE LAND:

The original thirteen States disposed of their land gradually, or still continue to sell land, excepting New York, Pennsylvania and Massachusetts.

All new States, originally not owners of any land, obtain huge tracts from the United States under special laws, famous among which is the Swamp Land Law of 1850. Under this law, about seventy-five million acres of land were granted to the new States. The large majority of the land thus granted was found to be not swamp land, but agricultural land. Claims under this law are still made by the counties to which the various States have usually ceded their rights.

As a rule, land forfeited for non-payment of taxes reverts to the State; such land is, however, usually claimed by the counties as well, and a clear title can be obtained only at a comparatively high expense by the State.

The Carey-act of 1894 donates to each arid-land State one million acres, with the proviso of reclamation by irrigation.

## (XXXI.) HISTORY OF STATE FOREST POLICY IN THE UNITED STATES:

**California:** State Board in 1885, as bureau of education with police power since 1887. Died in 1891, after issuing three botanical reports and establishing two experimental stations, which survive attached to the University of California.

**Colorado:** Is the only State emphasizing forestry in its constitution.

Futile attempts by the legislature to obtain control of the federal forests.

In 1885, a forestry commissioner appointed, soon without salary.

Since 1897, Department of Foresty, Fish and Game.

In 1901, law relative to camper's and hunter's licenses.

**Indiana:** In 1900 appointment of a State Forestry Board and a salaried forester. Tax exemption on small tracts having 170 trees per acre. Noted activity of John B. Brown.

In 1903, State reserves of 2,000 acres and State nurseries created.

**Kansas:** Forestry Commission in 1887. No action. Two State nurseries distribute seedlings.

**Massachusetts:** Law of 1882 encourages municipal forests. State Board of Agriculture, in 1890, instructed to report on forest condition. No action. Efficient forest association.

**Maryland:** 1902, bill pending for State Board of Forestry and State Park.

**Michigan:** In 1887, makes its State Board of Agriculture a Forestry Commission, but does not act on its report.

Efficient propaganda, under Senator Garfield, led, in 1899, to the establishment of a commission (3 members) charged with the preparation of a bill on forestry to be submitted in 1901. At the same time the commission was authorized to receive land donations, and to withdraw from sale 200,000 acres of land unfit for agriculture belonging to the State.

The bill on forestry submitted in 1901 as directed failed to become a law.

Chair of forestry, at Ann Arbor, since 1903 (Dr. Filibert Roth).

**Maine:** Appointment of a commission in 1869. An Act for the encouragement of tree plantations in 1872 grants tax exemption for twenty years. The State Land Agent since 1891 is Forest Commissioner.

**Minnesota:** Hinkley fire of 1894 stimulated action. Good forest fire warden law in force, township officials being ex-officio wardens. Chief Fire Warden C. C. Andrews issues annual reports and superintends the fire warden system. Forest reserve bill of 1900 (Captain Cross) authorizes Forestry Commission to accept land for park purposes. Small State park at Lake Itaska.

**New Hampshire:** Commissions of inquiry, 1881 to 1885, and 1889 to 1893; since 1893 permanent commission with paid secretary and annual report. Commission may receive land donations. The Society for the Protection of New Hampshire Forests, formed in 1901, employs a forester.

**New Jersey:** Geological Survey since 1894 carries appropiation for gathering forest statistics. Three reports.

**North Carolina:** Since 1891, a forester (W. W. Ashe) attached to the Geological Survey. Three reports. No action.

**New York:** In 1872, appointment of a State Park Commission which acquires within ten years 600,000 acres of wild lands forfeited for taxes. The State pays taxes on her own lands. In 1885, appointment of a commission for the protection of the forests, united in 1895 with other governmental branches, as, "Commission of Fisheries, Game and Forests." Duties: Superintendance of State forests; forestal education and suppression of forest fires all over the State.

Constitutional clause of 1893 prohibits lumbering in State forests.

In 1897, law relative to additional acquisitions within the Adirondack Park limits, through a "Forest Preserve Board"

In 1900, consolidation of Forest Preserve Board with Commission of Fisheries, Game and Forests, under the name of "Forest, Fish and Game Commision". Three members, holding office for four years, one salaried. The Commission employs thirty-two "fish and game protectors and foresters" at salaries of $500. per annum, three forestry eperts graduated from Cornell and a superintendent (Col. W. F. Fox).

Annual reports beautifully illustrated. Since 1903, single headed commission (D. C. Middleton).

State College of Forestry at Cornell, from 1898 to 1903.

**North Dakota:** In 1890, Commission of Irrigation and Forestry. No action.

**Ohio:** A forestry bureau issues annual reports from 1885 to 1887.

**Pennsylvania:** Forestry Association edits "Forest Leaves" since 1886. In 1893, Commission of Inquiry to report on water sheds and State lands, employing a botanist, an engineer and a statistician. In 1895, creation of Department of Agriculture with Division of Forestry, now advanced to department of Forestry excellently headed by Prof. Rothrock.

In 1897, efficient fire law, tax exemption on small tracts, and establishment of a State forest reserve by the purchase of three 40,000 acre tracts at the water-sheds, and of lands forfeited for taxes. Reserves aggregate, in March, 1892, 325,000 acres.

Ranger training school in 1903.

**Vermont:** Commission from 1882 to 1884. No results.

**West Virginia:** In 1897-98 bill for commission and State reserves. No action. Forest insectology well advanced by Dr. Hopkins at the West Virginia Agricultural Experiment Station.

**Wisconsin:** Creates in 1867 the first commission ever established by any State, headed by Increase A. Latham. No results.

In 1895, fire law after Minnesota pattern, but less effective.

In 1897, commission of inquiry co-operating with Fernow and reporting through Filibert Roth. No tangible result.

In 1898. fire warden law.

**REMARK:** Data relative to forestal history of States not enumerated are not available. For forestal conditions now prevailing compare § XLIII. f.f.

## (XXXII.) HISTORY OF FOREIGN POLICY.

Forest economy and forest management, like the economic use of any commodity, are required only at a time when forest products attain a value.

In Central Europe, this time fell in the period of strong, single-handed, aristocratic forms of government; and in the period of undeveloped means of freightage.

This fortunate coincidence of facts has allowed Germany and France to develop, in governmental and municipal forests, a conservative system of forest utilization imitated but not equalled in other European countries.

When at the approach and in the beginning of the 19th century, democratic ideas, mercantilism and improved facilities of transportation made their appearance, the principles of conservative forestry had impressed the public mind, for decades of years, so forcibly that they withstood the sway of altered conditions. Still, extreme financial stringency has forced European governments, repeatedly, to reduce the area of State forests.

In America, the increasing value of timber and lumber allows forestry to gradually dawn upon us. Will our form of government show sufficient strength, counteracting the influence of a splendid system of railroads joining the timbered region with the prairies as well as the seaports, to allow the sun of forestry to rise and shine forever?

### FRANCE.

1666 Colbert's forest ordinance places all forests under governmental control and forces private owners to adopt a management similar to that prevailing in crown forests.

1791-5 Almost ½ of State forests sold and spoiled; sales continue irregularly during 19th century, reducing State forest area to 1/5 of its pre revolutionary acreage. All restricions of private dispositions suddenly removed.

1803 Change of forest into farm prohibited for 25 years.
1827 Code forestier.
1860 First governmental attempts at reforestation in Alps and Pyrenees, preceeded by successful work on the sand dunes of the southwest (Gascogne).
1882 Model law relative to reforestation (Demontzey).
1900 Average annual expense for government reforestation $700,000. Annual expense for salaries and improvements in Algeria $600,000. Here, and in other French colonies (Tunis, Madagascar, Indo China, Reunion) governmental forest administrations are established.
1902 Superior foresters are trained at Nancy (technical school). Forest area totals 23,500,000 acres, composed as follows:
State forest 2,700,000 of which 600,000 acres are protective forests.
Municipal forest 4,700,000.
Private forest 16,100,000.

## AUSTRIA.

1800—1870 Financial stringency forces the government, from time to time, to sell large portions of the Crown forests.
1852 Law forbidding devastation and clearing, for farm purposes, of private forests by the owners.
Forests of protective character must be conservatively managed.
1853 Law enabling owner to free his forests from prescriptive rights.
1868 Tax relief on reforested land, for ten years.
1884 Law allowing expropriation of forests at the head of catch-basins.
1902 Total forest area, in Austria, 24,000,000 acres. Forest area administered by government staff: 2,500,000 acres.
14.5% of the communal forests, and 38.4 per cent. of the private forests, are conservatively treated, on the basis of working plans.

## DENMARK.

1805 High forests must not be cleared away. Intensive afforestation on sandy tracts and heathy land, ever since 1810, by governmental efforts and assistance.
1902 Private forests comprise 505,900 acres; State forests 142,140 acres. Almost 50% of all forests stock on land originally barren and waste. Forestry Academy at Copenhagen.

## HUNGARIA.

1880 Clearings on light sandy soil prohibited; reforestation in protective zone provided for; management of protective private forests regulated.

## SWITZERLAND.

1874 New constitution empowers the confederation to stop, on cantonal territories, turbulent creeks and to assist reforestation at head waters.

1876 Law specifically designates the cantonal districts within which the confederation may assume general control over protective forests, cantonal and communal forests, (which make up about 65% of total forest area).

Forest utilization in private forests of non-protective character is subject to cantonal regulations, independent of federal influence.

1897 Confederation obtains the right of inspection of forest police over the whole of Switzerland, by public "referrendum".

1902 Total forest area, 2,105,200 acres, equals 20% of the country, composed of:

Municipal forests, 1,403,700 acres.

Cantonal forests, 91,600 acres.

Private forests, 609,900 acres.

Splendid technical school at Zürich, where superior staff is trained.

## SWEDEN.

1902 Only ¼ of the private forests aggregating 58,715,000 acres (worth $5. per acre) is conservatively managed. Governmental restrictions prevail only with private forests stocking on loose and light sand.

A law tending to promote regrowth is being prepared. The State forests, aggregating 18,080,750 acres, yield a steady and increasing revenue.

Foresters are trained at the college of forestry at Stockholm.

## NORWAY.

1893 Law relative to forests and bare land of protective functions.

1902 Forests under governmental control aggregate 2,587,500 acres (value $2.70 per acre). Sustained yield. Private forests comprise 18,000,000 acres; only 280,000 acres are conservatively managed. Forests are over-cropped. Seeds and seedlings furnished from governmental establishments.

## ITALY.

1877 The contourline above which the chestnut ceases to thrive, generally circumscribes the forests of protective character, subject to restrictions known as "Vincolo forestale". Here reforestation is demanded; clearing prohibited; management regulated by the letter of the law.

A clause meant to facilitate the formation of forestry companies remains unsuccessful.

Financial inabilitiy prevents Italy from carrying into effect what plans her statesmen provide.

1902 The State forests comprise only 129,000 acres; private forests from seven to ten million acres (?)

Over ½ million acres require afforestation urgently.

Forest school at Vallombrosa.

## RUSSIA.

1888 All private forests must be worked according to conservative working plans approved by government. Private forests of protective character may be declared "forest reserves".

Seeds and plants can be secured from governmental establishments.

1902 Enormous forest area. In European Russia, 516 million acres, 60% of which are Crown forest; in Siberia, 1,250 million acres amongst which 725 million acres of Crown forest are surveyed. Forests are considerably underworked, owing to lack of railroads. After Mayr, growing stock in Western Russia lacks 60%, in Central Russia 30 per cent. from being normal.

Forestry schools at St. Petersburg and at New Alexandria supply the required forestal staff.

## CANADA.

1849 The first Crown timber act (about timber licenses).

1870 Quebec law respecting clearing of land and protection of forests from fire.

1878 Ontario law authorizing the Lieutenant Governor to create forest fire districts, by proclamation.

1883 Quebec forest reserve act, authorizing the Lieutenant Governor to set aside absolute forest land then under timber license as forest reserves.

(Repealed in 1888 and 1889).

1883 Ontario establishes a Bureau of Forestry, headed by a Clerk of Forestry, in the Department of Agriculture.

1885 Ontario creates system of fire rangers on timber limits; at common expense of limit holder and Government. (Aubrey White, Chief clerk of the Woods and Forest Branch of the Crown Lands Department).

1893 Algonquin National Park of 1,110,000 acres set aside in Ontario (tract is under timber license).

1895 Ontario Bureau of Forestry transferred to Department of Crown lands (Thomas Southworth, Director of Forestry).

1896 British Columbia Act relative to forest fire districts.

1897 Report of Ontario Forest Commission.

1898 Ontario Forest Reserve Act, resulting in the creation of the Eastern Forest Reserve (80,000 acres) and the Sibley Forest Reserve(45,000 acres), which contain second growth timber, and the Temagami Forest Reserve (1,408,00 acres).

1899 Appointment of E. Stewart as "Chief Inspector of Timber and

Forestry" in the newly created Dominion Forestry Branch of the Department of the Interior.

1901 Beginning of prairial planting under Dominion co-operation.

1902 Dominion Forest Reserves, set aside by Governor in Council, aggregate 4,082,000 acres. Total area of Canadian woodlands 800 million acres, of which 266 million acres, after E. Stewart, are properly timbered.

## GERMANY.

The development of forest policy in the States composing the empire is so diversified, that a general account only can be given.

A forestry movement began, on a large scale, in or about 1750, when a general timber and wood famine was predicted, in the absence of coal or means of transportation.

The mountain forests, at that time, had scarcely been touched by the axe.

The feudal system had prevented forest destruction, the feudal lords wishing to maintain the forests as harbors of deer. The foresters were hunting masters.

About 1775, steps were taken by the leading governments to secure a sustained yield from governmental forests.

About 1800, begins the epoch making activity of George L. Hartig and Heinrich von Cotta, founders of forestry.

When, about 1850, the fear of a wood famine had subsided, the idea and the ideals of conservative forestry had taken deep root in the public mind.

Restriction of the owners relative to the management of their holdings exist:

(a) Where governmental forests form a small percentage only of the total forest area.

(b) Where a forest has protective character.

Communal forests, however, are frequently found under governmental control or management.

About ⅛ of all German woodlands is free from any restrictions with reference to destructive lumbering.

A German government's practical forest policy, in 1902, consists of:

1. Conservative use and gradual improvement( roads; growing stock) of all forests under governmental control; combined with energetic increase of revenue derived from the forests;

2. Reforestation of all waste land,. frequently after purchase from private owners;

3. Purchase of small wood lots mismanaged by their owners; and gradual increase of forest area under governmental control;

4. Attempts at formation of forest-corporations;

5. Extension of fire protection over private lands;

6. Liberation of forests from the burden of prescriptive rights for timber, fuel, pasture, etc.;

7. Special control of protection-forests;

8. Education of rangers and foresters at governmental expense, often in connection with military service;

9. Measures tending to improve the position, the standing, the efficiency of forestry officials;

10. Plant supply from governmental nurseries, at cost, upon application by private owners;

11. Systematic forest researches through governmental experiment stations;

12. Opening all forests for public enjoyment.

## INDIA.

1855 Lord Dalhousie outlines a permanent policy for forest administrations.
1856 Dietrich Brandis appointed superintendent of forests in Pegu.
1864 Office of "Inspector-General of Forests to the Government of India" created.
1865 First Indian Forest Act passed.
1873 Establishment of a "Forest Survey Branch"
1878 Ranger school at Dehra Dun.
1878 Revised Indian Forest Act, promulgating rules for State forest reserves and for State Forest merely demarkated for protection; providing for village forests (ineffectively); allowing control over private holdings, if public welfare is at stake.
1884 Dr. Wm. Schlich establishes a "Working-Plans Branch."
1884 Forest School at Coopers Hill, England, in connection with the Royal Indian Engineering College under Dr. Wm. Schlich.
1898 Reserves aggregate, 81,414 square miles.
Protected forests, 8,845 square miles.
Working plans exist for 201 square miles.
Working plans are being prepared for 1,101 square miles.
1902 Staff:
(a) Administrative: 19 conservators.
122 deputy conservators.
170 assistant conservators.
(b) Executive: 437 rangers.
(c) Protective: 1226 deputy rangers and foresters.
8533 guards.

# Government and Private Forestry

## (XXXIII)...GOVERNMENTAL SAFETY MEASURES TAKEN IN PRIVATE FORESTS:

Governmental measures, affecting private forests, either assist (§XXXIII-§XXXV) or restrict (§XXXVI.) the owners dispositions.

Governmental assistance in private forests consists either in safety measures (§XXXIII) or revenue measures (§XXXIV).

Governmental action is lead by the idea that conservative forestry willl be practiced by private individuals if it appears to be a safe and renumerative investment. The measures consist of:

(a). Law making;
(b). Creating a staff to enforce the laws;
(c). Appropriating money to pay for the service;
Safety measures might be enacted:

1. With reference to forest soil:
   a. Good public records of real property, kept at the county seats, based on governmental surveys, combined with public maintainance of corner marks; laws punishing destruction of corner marks; laws relative to procession proceedings.
   b. Repeal of laws relative to forfeiture of property through non-use, since conservative forestry, seemingly, leaves the woods unused for decades of years.

2. With reference to trees:
   c. Laws spreading foresty morals through public schools and government divisions. (Arbor Day movement.)
   d. Governmental staff protecting trees together with fish and game.
   e. Laws preventing mice and insect plagues, and laws protecting useful animals.

3. With reference to forest fires:
   f. Laws relative to public roads.
   g. Laws enforcing help, in case of forest fires, from all able bodied males, and laws requiring an observer of forest fires to at once notify the nearest fire warden.
   h. Fire-warden laws. (Should not be elected; should be well paid by State and not by counties; should be efficiently controlled; should have small beats; and should be rewarded for good services.
   i. Laws relative to the burning of fields and woods by owners. (Give notice to adjoining land owners; fire only for clearing land in calm weather during certain months of the year and pay damages in case of escape of fires).
   j. Laws regulating camp fires, herder's fires, hunter's fires, duties of guides and guide-licenses.

k. Laws regulating the use of torch lights, tobacco pipes, matches, etc., and distance of cabins from woods.

l. Laws relative to fire lanes along railroad lines, (in coniferous woods minimum 70 feet; in broadleaf woods 50 feet); relative to spark arresters and responsibility of railroads for conflagrations.

## (XXXIV.) GOVERNMENTAL REVENUE MEASURES TAKEN IN PRIVATE FORESTS:

The leading idea in revenue measures is: that conservative forestry will be practiced when it is sure to pay good dividends, namely; when its products command a good price, and when its expenses are reduced.

Governmental revenue measures are:

1. Improvement of public roads, the government aiding the counties, as in New Jersey; providing road surveyors; and enacting efficient laws for making, maintaining and changing public roads. (Working roads by county prisoners; working roads by taxation; influence of stock law).

2. Proper railroad charters, controlling freight rates, and improvement of navigation.

3. Bounties for afforestation as granted in the prairie States; and for conservation as granted in Indiana, Pennsylvania and New York.

4. Release of taxes at expense of State, or better, of federal government, on the ground that:

A. Forest property lies unprotected and taxes are paid for protection only;

B. Forest are of benefit to the people and taxes should be paid by the beneficiary of an object.

C. The forest consists of soil plus crop. In forestry, as in agriculture, taxes should not be levied from a growing crop. Ernest Bruncken proposes to tax forest property according to gross revenue (like railroads). Tax reduction should be granted at the expense of the federal government, because:

a. A federal interest is at stake; the forest problem is an interstate problem;

b. A release of taxation of forest land should not result in an increase of direct taxation with all other realties.

The federal government draws its revenue from indirect taxation. Art. I,Sec. 8, of the Constitution provides, that "the Congress shall have power to lay and collect taxes and provide for the general welfare of the United States."

5. Free advice by the government as to the most remunerative way of using a forest (Pinchot's working-plans); further, as to the technical qualities of timber (Fernow's timber tests); and finally, as to reforestation on prairies and on abandoned land.

6. The establishment of governmental forest nurseries, (as in Canada) from which plants can be secured at cost price.

7. Governmental forest schools and ranger schools, to supply land owners with an efficient staff.

8. Governmental officering of private holdings with foresters and rangers upon request of owners.

9. Statistical publications showing the financial possibilities of tree growth on the basis of volume tables and yield tables. (see §XLI.)

10. Facilitating the formation of stock companies to practice forestry and authorizing the formation of county, town and city forests.

11. Sale of State forest property, if any, in large tracts fit for forestal practice.

## (XXXV.) FOREST OFFENCES.

Forest offences must be defined by legislature in a forest criminal code; must be prosecuted by governmental police according to criminal proceedings established by law; and must be punished by a judge and jury. The leading idea is:

Firstly, the restitution, for the benefit of the owner, of the original condition of affairs; and,

Secondly, the prevention of similar occurrences by deterring, through punishment, from similar unlawful acts.

According to the old Roman and Saxon laws, standing trees cannot be the object of larceny. After occupation, however,—like wild game and wild fish—they may begin to be objects of larceny.

Forms of offences are:

1. Damaging a forestal object;
2. Adversely occupying an object;
3. Endangering an object.

In North Carolina, the Code distinguishes between a felony, a crime punishable by death or imprisonment, and misdemeanors, the latter category comprising all other contraventions. The criminal proceedings cover arrest, jurisdiction, appeal, limitations, and other points. Fines can be converted into imprisonment by a Justice of the Peace or by a Court in case of inability to pay. In North Carolina, a jury answers only questions of fact, and not questions of law.

## (XXXVI.) GOVERNMENTAL MEASURES RESTRICTING THE OWNER OF FORESTS:

The measures taken by a government for the benefit of the people and restricting the rights of the owner are influenced by the following factors:

a. Climatic conditions.

b. Area of private forest as compared with the area of State forest and with the entire area of the State.

c. Importance of a given forest for the protection of lowlands, water supply, navigation, sanitation, etc.

d. Character of property, whether municipal entailed, or absolutely individual.

The extent of these restrictions might cover the following points:

1. Devastation of the forest.
2. Forest pasture, which might be prohibited, or restricted to

certain animal species (f. i. no goats) and to certain age classes of forest.

3. Burning the forest, which might be forbidden, or restricted to certain seasons and conditions.

4. Subdivisions of the forest below a specified minimum area.

5. Compulsory contributions to salary of administrative or protective staff.

6. Control of all working plans by State foresters.

7. Plantations forbidden close to fields.

8. Compulsory formation of forest companies.

9. Compulsory afforestation after clear cutting.

10. Exercise of mineral rights.

11. Enforced annihilation of logging debris.

12. Right of hunting and fishing, by limiting sport to certain seasons, sizes and sexes.

13. Expropriation of forest land where private forests have the character of protection forests (New York and Pennsylvania laws of 1897).

14. Diameter limit (New Hampshire).

# Forestry in Governmental Forests

## (XXXVII.) STATE OWNERSHIP OF FORESTS:

A. Reasons against State ownership are:

1. State managed industries have invariably proven failures, since they produce at a high expense, the manager not having a financial interest in the business.

2. Changing legislatures handicap the continuity of action, which forestry requires.

3. The American principle, ever since the first settlement, has been for the government to get rid of its holdings as soon as possible.

4. Underpaid officers, without pension rights, and often losing positions after short terms, are apt to defraud. Dishonesty in the forest is hard to discover.

5. Governmental forestry interferes, or may interfere, with private enterprise by entering into competition with it.

6. The commonwealth, under constitutional restrictons, is not allowed to pay taxes on its own land. Thus, the counties containing governmental reserves do not obtain taxes from such reserves. (New York pays taxes on the Adirondack Park.)

7. Dependence of all workmen and their votes on the ruling party.

B. Reasons for State ownership are:

1. Only in the case of forests owned by the commonwealth all production of the forest (health, water supply, stability of navigation and tangible products) is derived by the real owner.

2. Longevity of the commonwealth allows of a small rate of interest.

3. Large areas are required for conservative forestry.

4. Far sighted management cannot be expected from private owners.

5. Constitutional prohibition of entailed property.

6. The State pays no taxes; hence, State forestry is more renumerative.

7. The private individual never sacrifices direct forestal revenue for indirect revenue.

8. The commonwealth employs a police force (sheriffs, marshals, etc.) anyhow, and may secure, through the army and the militia, increased protection for its forests.

9. Possibility of special laws relative to trespass, firing, pasturing, squatting, and timber-stealing on State lands.

10. Where the government owns large tracts, there is no need to induce private individuals to manage their forests conservatively either by force or by premia.

11. Realties owned by the commonwealth increase the State's credit at exchange.

12. Some forests, namely, mere protection forests, must anyhow be controlled by the commonwealth, and the staff in charge of the State's protection forests might as well take charge of the State's revenue forests.

C. The federal government is better adapted for the practice of forestry than the individual States for the following reasons:

1. The head of a river from which the water comes, and the mouth of a river where inundations take place and where navigation is to be protected, are scarcely ever situated in one and the same State.

2. State governments are less educated, less conservative, and less far sighted than the federal government.

3. The federal government might avail itself of the army in officering reserves. The forestal staff, as in foreign countries, might yield officers and subalterns for the army in case of war.

4. Many States (Pennsylvania and Wisconsin) are prevented by their constitution from contracting loans which would be required for the purchase of forest reserves. The present generation is unwilling to run into an expense which is of benefit, especially, to future generations.

5. The federal government, receiving all indirect taxation, is rich. Raising money for forestal purposes by direct taxation increases the tax burden resting on the forest. The federal government might, as in other federal countries (Germany and Switzerland) make over to the individual States, out of excess revenue derived from specified sources, certain sums according to the population of the State for specified forestal purposes.

6. In America, the individual citizen shifts from State to State; has little interest in the forestal future of the State in which he happens to reside; is unwilling to be taxed for forestal developments in the State of his temporary residence.

## (XXXVIII.) PRINCIPLES OF STATE FOREST ADMINISTRATION:

A. Principles of organization.

1. Merit system; permanent employment; rank and salary increasing with duration of service.

2. Good pay; pensions as in the army.

3. Higher grades of officials (administrators, conservators, superintendents, chief foresters) to be secured from men commanding university or college training; lower grades or merely technical staff to be recruited from the best workmen.

4. The area in charge of an officer depends on land prices and stumpage prices, intensity of management, dangers threatening the forest and number of tasks (fish, game, roads, etc.) to be met by the official.

Example: In Germany a superior State forest officer is in charge of a range running from 2,500 acres up to 30,000 acres. Close to the cities, where prices are high, small ranges are required, and vice versa for mountain districts. The tendency is to decrease continuously the size of the ranges allotted to the care of an officer. These officers, as a rule, fully administer the State forests, within their precincts; whilst in communal forests, only silviculture and protection—in private forests protection only—is placed in their charge.

B. Rotation:

Rotation is the number of years which a forest is allowed to live. A high rotation usually means a large investment in stumpage and a low rate of interest. The indirect value of the forest is best protected by long rotations (160 years). Short rotations (20 years) are usually coppice and firewood rotations. A high rotation is advisable in State forestry for the following reasons:

1. The government can get along, being long lived, with a low rate of interest, and its investments must be absolutely safe.

2. A forest dealt with in a long rotation is more efficient in securing steadiness of water supply, navigation, public health, lumber industry, etc.

3. Private forestry will never produce large sized timber which may be required in the future as in the past.

## (XXXIX.) ADMINISTRATION OF FEDERAL RESERVES:

The law of June 4, 1897, authorizes an appropriation of $150,000.00 for the survey of reserves (Geological survey), and only $18,000.00 for administration proper. The principles of administration were given by the same law and cover:

1. The object of the reserves.

2. The public and private use of the reserves, namely; pasture, free use of their timber and stone, sale of dead, mature and large timber, rights of way, establishment of churches, schools and hotels.

3. Entry of mineral lands. (As usual).

4. Relinquishment of claims; so called forest reserve scrip.

The original appropriation for administration was entirely insufficient to answer the purpose. The appropriation during the last few years has been $300,000. (Since 1899).

### USE OF FOREST RESERVES, UNDER CONTROL OF GENERAL LAND OFFICE:

A. Timber:

1. Free use of timber, up to $20. (viz. $100.) stumpage value, granted upon application, open to settlers, miners, prospectors, residents, for their household needs, their mining and prospecting operations.

2. Public sale of dead, mature and large timber, usually by auction, after public advertisement, either upon application of interested parties, or for silvicultural purposes, by direction of General Land Office. Timber must not leave State of reserve.

3. Gross revenue, from cash sales, in 1902, $25,432.

B. Grazing: (free of charge)

1. In Oregon and Washington, limited (by the Secretary) pasture of sheep is permitted.

2. In other States and territories, sheep and goats may be admitted to an extent not deterimental to the object of the reserves.

3. Pasture of cattle and horses is permissible everywhere as long as forest growth and water supply appear unharmed.

4. In all cases, applicants must receive permits; Secretary fixes number admitted; stock of residents within the reserve has preference over neighboring stock.

5. In 1902, 1,200,000 sheep and goats were pastured, under 443 permits, in 8 reserves; and 460,000 head of cattle and horses were pastured, under 2642 permits, in 38 reserves.

C. Minerals: see (§XXVIII under "Sixth".)

Mineral lands are open to entry in all reserves, under the U. S. mining laws. Prospectors may obtain stone free of charge upon application. Proper care of reserves having mineral possibilities is greatly handicapped by unlimited privileges of prospectors and miners.

THE WORK IN THE FEDERAL RESERVES IS NOW DIVIDED AS FOLLOWS:

A. Department of Agriculture; Bureau of Forestry; working plans.

B. Department of Interior; Geological Survey; survey of land and timber.

C. Department of Interior; General Land Office; Division R; administration proper.

A bill tending to establish unification, strongly endorsed by Roosevelt's first message, was defeated (by Chairman Cannon) in 1902.

Division R consists of:

a. The office staff, divided into subdivisions for the appointment and distribution of the field force; for the sale of timber and for the free use of stone and timber; for privileges concerning churches, roads, mills, etc.; for grazing and lieu-land selection; and for changes and establishment of new reserves.

b. The field force, consisting of:

1. General Superintendents, who are the general inspectors and directors of field work in all reserves within one State. Nine appointed.

2. Supervisors, who are the managers of reserves or parts of reserves; correspond directly with Washington; grant free use of timber (up to $20. worth stumpage); and issue cattle and hog grazing permits to residents up to 100 head of stock. Salary depends on area and business transacted (about $2000.). Since 1902, permanent employment all the year around.

3. Assistant supervisors, also termed "head-rangers" or trained foresters. Scientific helpers of the supervisors and, at the same time, general field men. Salary about $1100.

4. Rangers of the first class permanently employed; must keep a horse and camping outfit; no expenses paid. Each ranger has charge

of a district and employs a variable number of guards working with, not under, him. He must be expert in timber work and surveying. Salary about $1000. 90 rangers employed. The work of the ranger consists of:

a. Patrol duty. ( 75% of the work).

b. Timber work, limited to urgent applications by miners and farmers. (In 1900-1901, there were sold 26,000,000 feet of lumber and 21,000 cords of firewood; 20,000 cords of wood were also given away.

c. Grazing work, under permit system, corresponding with the grazing period and the number of stock admissible in a reserve under orders from the Secretary

d. Miscellaneous work, namely; examination of mining claims, rights of way, church sites, stone supply, etc.

5. Rangers of the third class, also termed "guards", watching a certain beat. Salary of $60. per month. About 180 guards are employed for five months in the northern reserves, and 70 for eight months in the southern reserves.

6. Rangers of the second class, intermediate between 4 and 5 in salary, training, influence, responsibility, and permanency of position.

The total number of rangers, of all three classes, employed during 1902 was:

In January, 124 rangers;
In June, 275 rangers;
In October, 425 rangers.

The number of rangers kept on duty depends on the danger from fire extant in the various months of the year.

# Forest Political Miscellany

## (XL.) NATIONAL IRRIGATION LAW OF JUNE 17, 1902:

1. States: The law is applicable to all States and territories, excepting Texas, traversed by or west of the 100 degree of longitude.

2. Funds: The expense of survey, construction and maintenance of the works erected under the law is to be paid out of a "reclamation fund", supplied by,

a. Receipts from public land sales (deducting 5% for educational purposes) within the State benefited;

b. Receipts from sale of water rights at works constructed.

3. Motive:

a. The individual settler can enter or acquire small tracts only; the expense of irrigation works, however, is so great, that operations must be conducted on a large scale, for the benefit of many thousand acres at a time.

b. Irrigated farmland is more productive than farmland in the humid region depending on uncontrollable water supply.

4. Entry by settlers:

Land supposed to be irrigable can be withdrawn, by Secretary of Interior, from all entry, excepting homestead-entry. Unfortunately, settlers file claims invariably on withdrawn land, before feasibility of project is manifest. Commutation clause is here invalid. Entryman must reclaim 50% of irrigable land patented. Size of claims entered after publication of boundary to be irrigated is decided by Secretary of Interior. Secretary also fixes the water charges to be paid per acre of patent. Otherwise land is free to settler, like ordinary homestead.

5. Governmental work consists of:

a. Examination and survey (under F. H. Newell).

b. Construction, by contract, and maintenance of works for "'storage, diversion and development" of waters.

The Secretary of the Interior reports at each regular session to Congress, what works have been and are being carried out, and the expenses incurred on their behalf.

6. Operation of the irrigation works is left to an organization of the settlers obtaining water, under regulations approved by the Secretary. Minor distributing works are built by the homesteaders. Title to the reservoirs remains with the U. S.

7. Expropriation of private rights and private property required for the works is permitted. Indemnities to be paid out of the reclamation fund.

8. State laws and private water rights obtained under State laws are not cancelled or interfered with by the National Irrigation Act.

9. Main projects under consideration in 1903:

in Arizona: On Salt and Gila rivers;

in California: On Colorado river;

in Colorado: On North Platte, Gunnison and Grand rivers;

in Idaho: On Snake river;
in Montana: On Milk river;
in Nevada: On Carson and Truckee rivers;
in Utah: On Bear river;
in Wyoming: On Sweetwater river;
in Washinton: On Yakima river and around Lake De Smet;
in Oregon and Nebraska: relative to possibilities of artesian wells.

For the Truckee river project, contracts are already let. 300,000 acres will be irrigated from a canal 32 miles long.

The projects on the Gunnison (in the Uncompahgre Valley) and on the Salt river (Tonto, on east slope of Mazatzal) are reported well assured.

## (XLI.) FORESTRY INSTRUCTION, INVESTIGATION AND STATISTICS:

A. Instruction:

In order to propagate a knowledge of forestry, and in order to provide for a staff of foresters and rangers, a government may appropriate money:

1. For establishing forestry schools at State universities;
2. for establishing departments or divisions of forestry, forest commissions, etc.; and for publishing their reports;
3. for paying subsidies to forestry associations;
4. for sending teachers of forestry to address farmer's meetings.

However, the danger of "cranky" instruction by schools, reports and teachers, is great as long as men of practical experience are not available for the purpose.

B. Forestry investigation and statistics:

A knowledge of the financial possibilities of forestry is necessay for the owner of woodlands. Then, only, can he arrange his investments so as make them most productive of revenue. The knowledge must be based on investigation and statistics gathered by the government, since the private individual is usually unable to make them. He will never publish the result of investigations which he may chance to make. Most desirable are statistics on the following points:

Growing stock of timber in the U. S.; reproduction of timber; influence of fires; yield tables and volume tables; log analysis as to quality and quantity of output; timber consumption; timber export and import; study of foreign markets; influence of forests on water supply for irrigation and navigation; influence of the forest on rainfall, etc.

Of intrinsic importance in every country is a law defining, and causing to be demarkated, what forest is protection forest, and what land is absolute forest land. Necessarily, governmental measures must differ according to the quality of soil and according to the protective character which a forest exhibits.

## (XLII.) CUSTOM DUTIES:

1. On importations. (Logs, lumber, staves, naval stores, etc.)

A. Advisibility for the United States.

Reasons for custom duties are:

Checking importation results in higher stumpage prices; hence better chances for conservative forestry.

The wages paid for logging and milling lumber should remain in the United States.

Revenue is obtained through a tariff on logs and lumber.

Reasons against custom duties are:

Only the wood owners close to the Canadian frontier are benefitted since, practically, no other country imports dutiable lumber.

An increase in stumpage price may accelerate the destruction of the virgin forests, the owners doubting the stability of high prices.

As a matter of fact, the tariff of \$2. per 1000 feet of lumber influences forestry in the United States but little. Logs are on the free list, a concession made to American holders of Canadian stumpage. The United States export more lumber than they import. A tariff on the valuable hardwoods (ebony, mahogany, etc.) cannot effect forestry in the least.

The chief importations of forest products into the U. S., in 1902, were as follows:

| Product | Quantity | Value |
|---|---|---|
| Hemlock bark | 24,971 cords | \$ 103,930 |
| Cork wood and cork bark, unmanuf'd | | 1,816,107 |
| India rubber and guttapercha | | 25,652,977 |
| Cabinet wood, unmanufactured | | 3,3 1,275 |
| Logs and round timber, unmanuf'd. | 106,000,000 ft. b.m. | 907,168 |
| Timber, hewn, squared | 129,000 cubic ft. | 18,027 |
| Planks, deals and boards | 666,000,000 ft. b.m. | 9,271,090 |
| Shingles | 708,000,000 | 1,362,821 |
| Other lumber | | 1,380,973 |
| All other unmanufactured wood | | 3,309,622 |
| House furniture | | 714,857 |
| Wood pulp | 67,416 tons | 2,059,092 |
| All other manufactured wood | | 2,050,838 |
| Plants, trees, shrubs, vines | | 1,172,023 |
| Sumac, ground | 9,182,917 lbs. | 145,776 |

B. Custom duties abroad, in Germany. There is no duty on fuel, charcoal and pulpwood. Round logs pay \$ .45 per English ton; roughly hewn logs, raw spokes, raw staves, etc. \$ .90; and lumber \$2.25. The custom duty scarcely affects the price of German stump-importations of logs and lumber depend more on the prosperity of business than on the tariff figures.

2. On exportations.

Export premia are granted by countries either wishing to encourage export or else wishing to meet custom duties of countries to be invaded. Such premia are usually paid by means of a differential freight tariff; for instance, Austrian freight rates.

Export duties are imposed by countries in which forests are scarce or in which the supply of especially valuable species is approching exhaustion; or else, by countries which desire to encourage home manufactures of lumber by prohibiting the exportation of logs.

Example: South American States in regard to quebracho-wood; Ontario, for logs entering the United States. Timber cut in a U. S., forest reserve must not leave the State or territory producing it.

The chief exportation of forest products, from the U. S., in 1902, consisted of:

| Description | Quantity | Value |
|---|---|---|
| Sawed timber | 412,000,000 ft. b.m. | $ 5,225,003 |
| Hewn timber | 5,400,000 cubic ft. | 1,030,687 |
| Logs | | 3,343,908 |
| Boards and planks | 943,000,000 ft. b.m. | 16,978,322 |
| Joists and scantling | 38,000,000 ft. b.m. | 472,384 |
| Shingles | 33,000,000 | 86,799 |
| Shooks | | 1,498,919 |
| Staves | 47,000,000 | 3,830,432 |
| Heading | | 123,376 |
| All other unmanufactured wood | | 3,572,328 |
| Doors, sash, blinds | | 920,688 |
| Furniture | | 4,125,953 |
| Barrels, empty | | 127,603 |
| House furnishings | | 492,907 |
| Wooden ware | | 758,578 |
| Wood pulp | 38,000,000 lbs. | 740,103 |
| All other manufactured wood | | 4,451,858 |
| Wood alcohol | 626,925 gallons | 338,619 |
| Naval stores, (rosin, tar, turpentine) | | 11,733,562 |
| Ginseng | 154,063 lbs. | 856,515 |
| Bark and bark extract | | 288,012 |
| Nuts | | 304,241 |
| Nursery stock | | 132,027 |
| Agricultural implements | | 16,286,740 |
| Musical instruments | | 3,694,143 |
| Matches | | 57,742 |
| Paper and manufactures of paper | | 7,312,030 |
| Carriages and parts thereof | | 2,490,073 |

REMARK: The last five items are, obviously, not forestry products pure and simple.

# Forest Utilization.

## TO THE READER.

The Biltmore Forest School has offered annually, since 1898, a course of lectures on Forest Utilization—a vast topic comprising every art, every industry, all activity connected with the utilization of our woods.

If forestry is and means a business, then it is safe to say that forest utilization comprises the major—the by far major—part of the American forester's activity, provided that the term "forester" describes a man placed in charge of a forest and of its administration.

There cannot be any doubt that American forest utilization is conducted on the grandest, most ingenious scale which the world ever knew. The conditions surrounding and bearing it are entirely at variance from those now confronting the European forester. It is not to be wondered at, consequently, that little knowledge of American forest utilization can be gathered from European handbooks on European forest utilization or from European travels.

Like all disciplines of forestry, forest utilization had best be studied in and near the woods. Lectures delivered at a forest school, unless they be continuously illustrated by object lessons in the forest and in the workshop, can merely lay a bare foundation of the topic in the mind, or rather in the memory of the student.

The pages herewith submitted are printed primarily for the use of the students attending the Biltmore Forest School; they comprise the dictation given by the teacher during and after lectures; they are a skeleton of lectures merely, and it is the teacher's task to clothe the skeleton with flesh, obtained from his practical experience in the American woods.

There is ample reason to believe that one-sided and local experience has allowed a number of mistakes to creep into the following paragraphs. The Biltmore Forest School begs to be corrected by the reader, and any suggestions relative to errors and erroneous statements contained in this little publication will be most thankfully received.

Aside from the entire literature on forest utilization available in America and abroad, liberal use has been made of communications appearing in all of the leading trade papers; of the catalogues issued by the leading firms manufacturing implements for forest utilization; of the experience of the rangers and foremen of the Biltmore Estate; of information privately obtained through correspondence.

Most truly,

C. A. Schenck, Ph.D.,

Director Biltmore Forest School and Forester to the Biltmore Estate.

Biltmore, N. C., Sept. 1, 1904.

# Forest Utilization.

# FOREST UTILIZATION.

## § I. DEFINITION.

The term "forest utilization" comprises all acts by which forests—the immobile produce of nature—are converted into movable goods or commodities. Considered as a science or as an art, forest utilization constitutes the major part of forestry now practiced in our new country, abounding in forests.

As a discipline, forest utilization may be divided into two main parts, namely: "logging operations" and "manufacture," arranged in the following five chapters:

Chapter I. Labor employed in the forest.
Chapter II. Cutting operations.
Chapter III. Transportation.
Chapter IV. Foundations of manufacture.
Chapter V. Manufacturing industries.

## § II. LITERATURE.

There exists, unfortunately, no handbook on American forest utilization, although forest utilization shows a higher development in the United States than in any other country.

Among the foreign literature on forest utilization, publications of the following authors are particularly worthy of note:

Carl Gayer, Richard Hess, William Schlich, Hermann Stoetzer, Carl Grebe, Wilhelm Franz Exner, Carl Schuberg, Heinrich Semler, H. von Noerdlinger, Carl Dotzel, E. E. Fernandez, L. Boppe, M. Powis Bale.

# Part I. Logging Operations.

## CHAPTER I. LABOR EMPLOYED IN THE FOREST.

### § III. MANUAL LABOR.

A. Duration of employment.

I. Determining factors are:

(a) Climatic conditions;
(b) Economic conditions;
(c) Local custom.

In the South, work lasts all the year round.

In the Lake States and in New England, late fall, winter and early spring (from four to eight months) comprise the usual period of activity.

In the European mountains, logging is restricted to the summer months; in the European lowlands, to the winter months.

II. Advisability of continuous employment in conservative forestry, especially in the case of foremen and sub-foremen, leads to the adoption of means tending to attach the laborer to his job and to his employer.

Such means are:

(a) Advances for tools.
(b) Rent of cabins and farms at reduced rates.
(c) Help in case of sickness and accidents.
(d) Wholesale purchase of victuals so as to give the workmen the benefit of a reduced price.
(e) Firewood, forest pasture and forest litter free of charge.
(f) Permission of agricultural use, for a number of years, of clear cut areas. (This last system is called in India "tongya.")
(g) Employment during the season when cutting is stopped, in road building, fire patrol, planting, weeding, nursery work etc.
(h) Possibility for hands to rise to a foreman's position.
(i) Encouragement of home industries so as to keep the workmen busy on rainy or cold days, i. e., basket weaving, shingle making, wood carving, sieve making.

It seems most important to supply the family of the woodworker with a comfortable home and school and church advantages.

B. Remuneration.

I. Means of remuneration.

(a) Money. Wages in the South are from 50 to 75 cents a day. At Biltmore, now $1 per day, even in the mountains. On the Pacific coast, $2 to $3 per day. In Lake States, $18 to $32 per month, plus board; dry days only included.

(b) Commissary bills. This method of payment is used in the South only, in connection with colored labor.
(c) Privileges (house, farm, pasture).
(d) Board. Expense at Biltmore, per capita, 25c to 30c; in Lake States, 40c to 50c per day. Wages of camp cooks in Lake States, $50 and over per month; at Biltmore, $15 to $30 per month.

Victuals required per capita, see "Lumber and Log Book," page 144.

II. Scale of remuneration.

Wages depend on the effect of labor or on the values created by labor.

Influencing factors are:

(a) Density of population.
(b) Human strength and technical skill required.
(c) Silvicultural understanding required.
(d) Hardships endured and risks taken.
(e) Prices of the necessary victuals.
(f) Length of day during cutting season. Compare page 162, "Lumber and Log Book."

Where contract work prevails, the following additional factors come into play:

(g) Tools supplied by employer or employee.
(h) Softwoods or hardwoods.
(i) Amount to be cut per acre.
(j) Configuration of ground and remoteness from roads.
(k) Distance from home village.
(l) Possibility of continuing work during rain.

Experiments have shown that workmen paid under contract per one thousand feet b. m. earn more money in big timber than in small timber, and that a system of payment according to the diameter of the log is far more just.

C. Method of employment.

In France the woodworkers are employed by the purchaser of stumpage; in Germany, invariably by the owner of the forest. In America, both systems are found, the former prevailing. Whether the German or French system is preferable is an open question.

I. Hands are usually recruited from farm laborers, hence advisability of locally combining agriculture and forestry. In addition, the employees of the building trades, unoccupied during winter, supply help for the lumber camp.

II. Day work is advisable in preference to contract work

(a) Where quality (effect) of labor cannot be controlled, notably in nursery work;
(b) Where experienced hands must be trained;
(c) Where contract labor cannot be obtained (Pacific coast);

(d) Where contract legislation is bad. (Lien laws in Minnesota; $1,500 exemption clause in North Carolina.)

III. Contract work is generally preferable to day work because it is cheaper. Contract work is doubly advisable where employer's liability laws work against the employer. Contracts should always be in writing. The specification sheet should be kept apart from the paragraphs of agreement, so as not to encumber the contract.

The main clauses of a contract cover:

(a) Time allowed to complete work;
(b) Installments and payments;
(c) Building of snaking roads, sleigh roads and skidways;
(d) Scaling of defective logs and of sound logs;
(e) Employer's liability;
(f) Fines for fire, stock at large, fishing, hunting and drunkenness, and demand for discharge of culprits;
(g) Shanties and log houses and commissary bills;
(h) Supply of tools; deduction for loss and spoliation of tools;
(i) Fines for cutting trees not marked or of too small a diameter;
(j) Fines for leaving marked trees uncut;
(k) Fines for poor work and unnecessary damage;
(l) Possibility of speedy termination of contract in emergency cases;
(m) Nomination of umpire to avoid suits in case of discrepancies.

The specifications cover the following points:

Height of stumps; peeling of bark; separating product according to quality; length, diameter, weight of product; nosing logs; cutting defects out (unsound knots etc.); placing the product on sticks (so as to allow it to dry) or on skidways; method of carrying or moving products; swamping (removal of branches); use of road poles (breast works); skidways; road building.

D. Subdivision of labor.

The leading principle is that one division gang must push the other.

I. Lumbering.

(a) Cutting or felling crews, consisting usually of two hands; sometimes a third man to drive wedges and to make the axe cut.
(b) Log makers, dissecting the bole into logs. A foreman should be an ex-sawyer or an ex-lumber inspector.
(c) Swamping crew, to clear trees of branches and to open suspicious knots.
(d) Snaking crew—at Biltmore five hands for a three-yoke team; three men to get the logs ready and to remove brush (debris) and two men to accompany the load.
(e) Skidway crew—two hands rolling logs onto skidways.

(f) Road crew—meant to prepare snaking or sleigh roads; to sprinkle and sand ice roads.

II. Firewood or cordwood making (for pulp, distillation, cooperage etc.).

a, b, and c are the same as in "I.—a, b and c."

(d) Carriers or carrying crew—often with hand sleighs or rollers or grapple hooks.

(e) Splitters—with heavy axes which have broader, thicker cheeks than cutting axes.

(f) Piling crew—a very careful, honest man is required for piling the wood.

### § IV. ANIMAL LABOR.

A. Countries.

In Europe, even in virgin forests, practically none is required. In India and possibly in the Philippines, elephants are used.

In the United States, in the Southern and Pacific States, as also in the Appalachians, oxen are used. In the Lake States, Pacific States and New England States, horses are preferred. In the South, mules are used for small logs and especially on tram roads.

B. Horses.

I. The numerical ratio between hands and horses in Northern camps varies from 2 to 1 to 6 to 1.

The standard amount of work for one horse is:

(a) A haul of 1,600 lbs. inclusive of wagon, on a level road over 23 miles per day.

(b) An output of 2/3 horsepower per minute, equal to 320 horsepower per day of eight hours.

II. Horses are employed for

(a) Skidding or snaking.

(b) Rolling logs on skidways.

(c) Sleighing, trucking (two wheels) and wagoning (four wheels).

(d) Go-deviling.

(e) Loading on railroad cars.

(f) Supplying power for portable mills.

III. Food for horses.

(a) Interdependence between feed and effect in foot pounds per 1,000 lbs. horse flesh during a day's work is:

| | | | |
|---|---|---|---|
| Straw .................. | 2 lbs. | 2 lbs. | 2 lbs. |
| Hay ..................... | 19 lbs. | 15 lbs. | 11 lbs. |
| Oats .................... | 2 lbs. | 6 lbs. | 10 lbs. |
| Effect .................. | 3,000,000 | 9,000,000 | 15,000,000 |

(b) Food required.

After Thaer, per 1,000 lbs. of horse flesh, 25 lbs. of good hay and oats.

After the "Lumber and Log Book," 50 lbs. of oats and 40 lbs. of hay per team per day.

(c) Feed values equivalent to 100 lbs. of good hay, after Haswell, are
= 54 lbs. of barley.
= 57 lbs. of oats.
= 59 lbs. of corn.
= 275 lbs. of green corn.
= 374 lbs. of wheat straw.
= 400 lbs. of cornstalks.

C. Mules.

I. They are employed for:
(a) Light logs on good ground and for long distances.
(b) For wagoning lumber and provisions.
(c) For hauling on rail tracks (wooden and iron rails).
(d) For hoisting logs on inclines.
(e) For plowing and scraping in road and railroad building.

II. Food for 1,000 lbs. mule flesh, as for horses.
Mules require less care than horses, taking care of themselves and resisting overwork. They are frequently not fed at noon. (Price per team at Biltmore, $200.)

D. Oxen.

I. Price per yoke is from $80 to $120, weight from 2,000 to 2,500 lbs.
Ox yokes form the rule, although efficiency of oxen in harness is superior. Shoeing for each claw separately—difficult and risky, but necessary on hard ground.

Special training takes place from second year on. Fitness for hard work begins in the fifth year, when ossification of bones is completed.

Special training for leaders.

II. Employment.
In the South for snaking heavy logs—or log trains in Oregon; for hauling logs suspended underneath high two-wheel trucks in the pineries; rarely for loading cars or wagons.

III. Standard work.
An ox walks 14 miles per day with load. An ox yields in eight hours of work 270 horsepower, hence he produces only four-fifths of the effect of a horse.

After Thaer, an ox produces only one-half as much power as a horse of the same weight.

IV. Feed.
(a) It is much cheaper to feed oxen per 1,000 lbs. living weight than to feed horses of same weight.
Ruminants have four stomachs and thus digest their food better. No feed is given in the middle of the day, and no expense is incurred during idle periods, where pasture is available.

(b) Careful treatment and good stables required. Oxen must not be hurried. Soft yokes, proper salting and regular watering.

(c) In the South, at the present time, cottonseed meal and hulls form the cheapest food. Food requirements per yoke per day are 25 lbs. of meal and 40 lbs. of hulls. Present prices of meal $25 per ton and hulls $8 per ton, delivered at Brevard, N. C.

# CHAPTER II. CUTTING OPERATIONS.

## § V. WOODSMEN'S TOOLS AND IMPLEMENTS.

A. Axe. It consists of a handle, 32 inches to 42 inches long, made of hickory, ash, locust or mulberry, either straight or "S" curved, and of a blade or head forming a steel wedge of particular temper. The cheeks of the wedge are slightly curved in the midst, falling down gradually towards the upper and lower line. The weight lies either close to the bit or close to the handle, according to local predilection.

The best make is the Kelly axe.

Double bit axes, requiring straight handles, are largely used in the Northeast. Special splitting axes, of greater weight and broader cheeks, are rarely used (for sugar barrel bolts and retort wood).

For hardwood, a thin and light axe (a cutting axe) is preferred, while for softwood a broad and heavy axe is used (a tearing axe).

A box of axes contains an assortment of various weights. In Europe the bit is relaid with steel, after wearing off.

The axe is used

I. For cutting trees entirely or partly.
II. For swamping (axe to be ½ lb. heavier).
III. For splitting.
IV. For nosing logs.
V. For driving wedges.

Price of axes from $6 to $8 a dozen. Handles are $1 a dozen.

B. Adz and broadaxe.

The adz and broadaxe are used for trimming and barking export logs, squares, ties and construction timber. The blade of the adz stands at right angles to the plane of the sweep and has such curvature as corresponds to the curve of the sweep through the air. The cutting edge is ground concave on the inner side.

The broadaxe is either right or left sided, the plane of the blade forming an angle of 5° to 10° with the plane of the handle. The handle is usually short, the blade very heavy and wide.

C. Peavies.

The peavy is a typical American tool, not used elsewhere. The best make is Morley Bros.' line of blue tools.

The hooks are distinguished as round bill, duck bill and chisel bill hooks, made of hammered steel. The socket is either solid or consists of rings. The square pick (point) is driven cold into the round bored point of the handle. The handle is 4 to 6 ft. long, straight, 2½ inches to 3 inches through and is made of hickory, ash, or usually hard maple. Price per dozen is $10 to $22.

A peavy must answer the following requirements:

I. Hook adapted to any size log.

II. Bill to be so constructed as to catch securely through any layer of bark.

III. Proper length, greatest strength and low weight.

D. Cant hooks.

The cant hook is a peavy, lacking the pick (point).

The socket consists of two rings only joined by a narrow bar.

Cant hooks are used more in the mill and yard, peavies more in the woods.

E. Cross-cut saws.

I. Radius experiments show a radius of 5 feet 2 inches to be best. The straight drag saws require excessive strength and are deficient in dust chambers.

II. Width of blade.

It is at the widest point about 8½ inches. The hollow back saws, a very recent invention, have only about 4 inches width all through.

III. Thickness of blade:

The back of the saw is always somewhat thinner than the gauge of the teeth. Henry Disston gives the saw backs 4 or 5 gauges less thickness than the saw teeth. Atkins gives the teeth "14 gauge," the back at the handles "16 gauge" and at the center of the back "19 gauge."

IV. Uniformity of temper and proper temper are obtained by special processes. No hammering of blades. Cheeks are perfectly smooth.

V. Construction of teeth is very variable. Dust room between the teeth should be twice as large as the teeth.

For hardwoods more teeth are necessary than for softwoods.

There are two kinds of teeth, namely:

(a) The cutting teeth, a couple or trio of which might be arranged on a common stock, to form "Tuttle or Wolf Teeth." Only the points of the cutters actually cut into the fibre.

(b) The raker or cleaner teeth, meant to plane off the fibre severed by the cutters and to shift the sawdust out of the kerf. European experiments prove the uselessness of cleaners. They simply occupy valuable dust room. The point of the rakers should recede by 1/32 of an inch from the cutting line of the cutting points.

VI. Length of saw is from 4 ft. to 8 ft. At Biltmore 6½ ft. and at Pisgah 7 ft. is preferred.

Local crews use the "diamond cross-cut," the "champion teeth" and the "hollow back" saw.

VII. Saw handles should be easily detachable. The material of the handle is maple, birch and hickory. Handles are fixed (usually) vertically to back of saw. Sometimes, however, they are in the direction of the radius of the saw.

Large "bow" saws allow of a very thin blade and have a bow instead of handles. They are not used in America.

VIII. The effect of a saw is equal to the number of square inches cut by one man per minute. The effect is small in pole-woods, increasing gradually up to a diameter of 1¾ ft. and decreasing thereafter owing to increasing friction.

In cutting longleaf pine, the saw is continuously sprinkled with turpentine.

The effect of curved saws is from 40 % to 50 % higher than the effect of straight saws.

The saw overcomes

(a) The resistance of the fibre by the sharp points acting as knives and planes;

(b) The friction at both cheeks of the blade by smooth cheeks and by a gauge narrowing toward the back;

(c) The friction of sawdust by deep teeth, curved line of teeth, perforation, large dust chambers and possibly by "cleaning teeth."

IX. Dressing of cross-cut saws.

(a) "Jointing" means filing all cutting teeth down to exactly the same circumference.

The tool used is called a jointer. A file is placed in the joints and by a screw pressed into the proper curvature.

(b) "Fixing the rakers" means filing them down with the help of a raker gauge. The rakers act as brakes if they project into the cutting line. Outside and forks of rakers are slightly filed to remove case hardening, and the point is sharpened to a planer edge.

A raker swage is being introduced to spread the points of the rakers and to give them a hook-like point, which is said to tear out long slivers instead of tearing out dust.

(c) "Setting the cutter teeth" is done under the control of a "set gauge" with the help of a "set block and hammer," giving 3 to 4 taps (the best method when done by experienced men) or with the help of a "saw set." "Saw sets" are constructed either wrench-like or after the hammer and block principle.

Rules of setting are:

1. Setting should never go lower than half the length of the tooth.
2. It should never exceed twice the gauge of the teeth.

3. More set is required for long saws and for soft woods than for short saws and hard woods.
4. When hammering, strike tooth fully 1/4 inch from point of tooth.
5. If teeth are badly set, take, to begin with, all set out of the teeth.
6. Apply side file inside file holder, to take away slight irregularities of set (after filing the teeth).

(d) "Filing." Filing usually follows setting except in the case of saws spanned in a vise, when the set is afterward given by holding the set block on one side of the spanned saw and hammering from the other.

Rules of filing are:

1. File inside of tooth only.
2. File to a bevel or fleam of 45°
3. Push the file away and do not draw it toward you.
4. Do not file point to a feather edge.
5. It is useless to sharpen tooth below the cutting point.

(e) "Gumming." Gumming is usually done with the file; the lever (punch) gummer may be used for the purpose, however.

(f) Remarks: A good, well-tempered saw holds sharpening and filing for six work days.

In California one man "cross-cut saws" up to six feet long are used in dissecting the bole into logs.

The cross-cut saw file shows, on the cross section, a narrow triangle with curved back.

In Europe flat and triangular files are used for cross-cut saws.

The "spread set" of the cutting teeth has been tried and was found impracticable.

F. Wedges.

Wedges are used:

I. To split wood. The "axe wedge" is usually made of iron and should have straight and not convex cheeks, which are often grooved to prevent wedge from jumping the cleft.

Wedges are sold by the pound.

Iron wedges are prevented from jumping by heating them, by putting dirt in the cleft, or else a rag (wet) over the wedge.

Wooden wedges are made of the butts of hard maple, hornbeam, black gum, dogwood and beech.

Iron wedges with wooden backs are frequently used abroad.

II. To prevent saw from pinching in the kerf.

Special saw wedges of oil-tempered steel are made by Morley Bros.

Frequently saw wedges and axe wedges are used alike.

Wooden wedges must be driven with the axe or hammer.

Iron and steel wedges must be driven with a wooden maul.

G. Mauls and maul bands.

Mauls are made of the butts of dogwood, beech, hornbeam, hard maple, gum and locust, and are held together by two iron hoops made of ½-inch by ¾-inch flat iron.

H. Pickaxe and mattock.

They are used where the stumps are used together with the bole and in the preparation of forest roads. The points of both are relaid with steel after wearing out.

I. Brush hooks.

They are used in cleaning boles and in making fagots or fascines; further in clearing snaking roads in dense underbrush.

J. The krempe.

The krempe is used largely abroad and in India and resembles the picaroon or hookaroon used in America for handling ties, telegraph poles and pulp wood. It is used in rolling and moving logs down hill, the pick acting as a lever, the fulcrum of which lies at the heel.

K. Pike poles.

Pike poles are used with pike and hook or with pike only; are 12 ft. to 20 ft. long, made of selected white ash, the points consisting of cast steel. The points are either screwed into the wood or driven without heating. Pike poles cost $10 to $25 a dozen. They are indispensable in driving and rafting operations and at mill ponds.

L. Screws for blasting stumps. Such screws are used abroad, not to shoot stumps out of the ground but solely to split stumps where prices of firewood are high. The hollow screw loaded with blasting powder is inserted into an auger-made hole.

M. Grindstones.

Grindstones should not be exposed to the sun, should be kept equally round and even and should always be kept wet while in use. A water trough underneath the stone should be rejected, as the submerged side softens unduly and unevenly. Stones are sold by the pound.

A 70-lb. grindstone costs about $4. The extra fixtures, consisting of hubs, shafts with nuts, crank etc. cost about a dollar.

N. Machine saws.

For cutting trees such saws have proven a failure. Similar was the fate of the "electric cutting machine" recently patented by Bayer. The expense of carrying machines from tree to tree is greater than the expense of cutting by hand.

O. Tree-felling machines.

They are largely used abroad to obtain the stump of a tree together with the bole.

I. One of them is the "Nassau machine," consisting of a 4-inch board 10 inches wide into which regular steps are hewn, and of a pole about 25 ft. long, with a crooked pike at the small end and squarely bound in iron at the big end. Half a foot above the big end the pole is perforated so as to receive a 1½-inch round steel spike. The square base of the pole is placed on a step of the board, fixed flat on the ground, some 12 feet from the tree. The pole then forms an angle of about 50° against the board, while the spike is securely placed into the bole of the tree. By means of two crowbars the base of the pole is moved step by step toward the tree. This machine must be used in Hesse Darmstadt, under the employer's liability law.

II. The "wood devil" has been used for centuries in Switzerland. A rope or cable is fixed in the top of the tree to be felled and a chain is fastened around a stump in the falling direction, which chain ends in two hooks. The lower end of the rope is secured to a chain, the links of which receive the hooks. By moving a long lever to and fro, the hooks are inserted alternatingly in the chain end of the rope, advancing two or three links at a time.

The instrument is very cheap, simple and powerful; at an angle of 45° the rope has the maximum of power.

III. To remove stumps alone the stump lifter might be used.

IV. "Weston's differential hoist" lifts the maximum of weight with a minimum of its own weight.

A Weston hoist capable of lifting 1½ tons 8½ ft. high weighs only 81 lbs. and costs $25.

## § VI. FELLING THE TREES.

Under "A" and "B" are described the chief methods of felling.

A. Obtaining bole without stump and roots:

I. By exclusive use of the axe, handled from one side only in cutting small trees, in thinnings and in coppice woods.

II. By exclusive use of the axe, cutting two kerfs on opposite sides. The first notch, on side toward which tree is intended to fall, made from 4 inches to 6 inches lower, must penetrate the center of the tree. Avoid felling toward the direction in which the tree leans.

Advantages of this method are the facts that one tool and one man only are required; that the bole is easily directed; that the logs obtain proper noses.

Disadvantages are loss of bole, amounting to from 4 % to 8 % and loss of time and labor in large timber. This method of felling is universally used in Maine.

III. By hewing "out of the pan," a method used for valuable heavy boles. Uncertainty of fall is counterbalanced by a gain in the length of the bole. The bole thus obtained is said to show less heart shakes.

IV. By using the two-handed cross-cut saw alone, without the help of the axe, a method not advisable for the reason that the fall of the bole cannot be directed.

V. By joint use of cross-cut saw and axe. The axe cuts a kerf on the falling side, the depth of which is 1/4 to 1/5 of the diameter, and the innermost point of which lies on a level with the saw kerf. When the saw begins to pinch, drive wedges behind the back of the saw. Withdraw the saw when the tree begins to shake heavily and force it to fall by wedging.

Advantages of this method are: the trees are easily directed at a small loss of timber.

Disadvantages are: several tools and several men are required. In very thick woods and on very rocky, steep slopes, the use of the saw is not advisable or possible. Careless wedging may cause the bole to split at the butt. The saw and the wedge are said to be responsible for heart shakes.

B. Obtaining bole with stump and roots:

It is essential to thoroughly sever the main roots with axe, mattock and pick. The tree is then forced over by a tree-felling machine, or with a rope fastened to a high limb.

Advantages are: longer bole; gain of lumber 8 % to 10 %. Possibility of obtaining knees for ship building (tamarack and white oak). The tree falls gently, its fall being checked by the roots so that the bole shows less splits, cracks and wind shakes. The bole is less apt to break and can be allowed to dry out gradually. Further, root-breeding insects don't find any incubators and agricultural use is facilitated.

Disadvantages are: greater expense, more tools, axes ruined in cutting roots, extra saw cut required to sever the butt log from the roots and, above all, the delay in finishing the logging job.

C. Criteria of a good method:

I. Danger to workmen.

II. Total net value obtained.

III. Wastefulness.

IV. Possibility of throwing the tree in the desired direction.

D. Pollarding before felling:

The branches or the tree tops in European logging are frequently lopped off before felling, for the following reasons:

I. The younger generation of trees surrounding the tree to be cut receives less injury.

II. Lopped trees touch the ground all along the bole at one and the same time. Hence no danger of the bole's breaking or splitting. In addition, a reduced crown causes the tree to fall with decreased force.

E. Felling rules:
   I. The trees must be thrown in such a way as to do least damage to themselves, to surrounding trees and to undergrowth.
   II. The felled tree should lie in a position allowing of easy dissection of bole and of easy removal of logs.
   III. Operations must be stopped during storms and blizzards.
   IV. Trees over 6 inches in diameter should be sawn down, coppice woods excepted.
   V. No more trees should be felled than can be worked up within reasonable time after felling.
   VI. The stumps should not be higher than the tree's diameter.
   VII. All trees marked for cutting, and none else, must be cut.
   VIII. The tops should be swamped so that they may come in contact with the ground.

### § VII. DISSECTING THE BOLE OF THE TREE.

A. Purpose of dissection.
   I. Reduction of freightage.
   II. Better adaptation to different methods of transportation required for different assortments.
   III. Better accommodation of buyers requiring different assortments.
   IV. Obtaining manageable size of logs and wood.

   As much net value should be obtained from the bole as possible. Waste is advisable wherever it pays to waste.

   In no forest on earth is all the woody substance produced marketable. The amount of offal (waste, debris) depends merely on the expense of transportation to markets within nearest reach. It is better to waste wood than to waste money. The modern lumberman gathering logs of 4 inches diameter and the modern forester objecting to any waste frequently neglect this rule.

B. Factors influencing the dissection:
   I. Requirements of the market governed by custom.
   II. Distance from market: the longer the distance, the better must be the quality of the product.
   III. Locality (f. i. steepness of slope; swampiness).
   IV. Local laws (f. i. in North Carolina relative to 8-foot firewood).
   V. Available means of transportation and their construction.
   VI. Freight rates varying with the degree of conversion.
   VII. Size of cars and wagons.
   VIII. Length of mill carriage and of feedworks.

C. The main divisions of woody produce obtained from dissected boles are:
   I. Piece stuff, i. e. logs, blocks, construction timber, sold by the foot, the standard, the pound.
   II. Numbered stuff, i. e. poles, posts, mine props, scaffolding poles and shingles, boards and staves, sold by the dozen, by the hundred, by the thousand etc.

III. Space stuff, i. e. industrial cordwood (for insulator pins, bobbins, pulp, tannin etc.), tanbark and fuel, sold by the cord. In the case of bark, 2,240 lbs. are usually considered the equivalent of one cord.

D. The specifications governing the dissection describe:

I. The dimensions, i. e., the range of length and diameter desired for each section obtainable.

II. The quality of each section and the defects allowed and prohibited therein.

(a) Saw logs for lumber.

1. Dimensions. Douglas fir on the Pacific coast used to be cut in logs 24 ft. long. The minimum diameter permissible was 30 inches.

Spruce in New England is often cut 13 ft. 4 inches long with a diameter of 6 inches and up.

For yellow pine logs, any length and any diameter over 8 inches are permissible.

Hardwood logs have a length ranging from 6 ft. 4 inches to 18 ft. 4 inches, arranged in intervals of 2 ft. Odd lengths are scaled down. A deficiency of 1/4 ft. in length of board or less is, however, often disregarded.

Export logs of yellow poplar are 8 ft. and 16 ft. long.

Jack pine logs for cheap box lumber are often cut 6 feet 6 inches long, the diameters ranging from 4 inches upward.

2. Treatment. Saw kerfs at either end of log should be made perpendicular. Branches should be swamped off, knots cut level and laid open. Bark in the case of conifers is frequently peeled off in Maine and in Europe. Bark rings are sometimes left at the ends. Defects of bole must be concentrated in one log, or must be sawn out. Nosing is required for loose driving and for snaking. Painting of end faces with red lead is prescribed for export logs. Very heavy logs are sometimes split in two. Putting logs on sticks to prevent spoliation of sap and to reduce specific gravity is often advised.

(b) Blocks for woodenware.

Poplar, for large bowls, must be entirely free from defects. White pine blocks are often cut between the whirls of branches.

(c) Hub blocks must be butt logs, the length allowing to cut either two or four out of the block.

(d) Construction timber is hewn according to local requirements. Minimum diameter at small end most important. Construction timber abroad is sometimes whip sawn.

(e) Poplar and walnut squares run from 4" x 4" to 10" x 10". They are whip sawn in the backwoods of western North Carolina.

(f) Telegraph poles. The smallest diameter, the diameter at or close to the big end, the length, crooks and treatment of bark must be considered. Sometimes pointing of the small end is specified.

(g) Fence posts. Species, length, smallest diameter, straightness, method of manufacture etc. must be considered. Usual length is 6½ feet.

(h) Railroad ties. Specifications are very variable. Face is usually from 6″ x 6″ to 7″ x 9″. Sawed railroad ties are used, especially in the yellow pine section. Great waste in hewing ties from trees just too small to yield two ties. Specifications cover allowance of sap, wind shakes, wany edge and dote.

(i) Shingle bolts. Lengths are multiples of 16″ and 18″, usually.

(j) Mine props. Middle diameter from 3″ to 8″.

(k) Stave and heading bolts. Basswood heading bolts used in Michigan. Length 18″ or 37″ and diameter not less than 8″. If from 12″ to 18″, split into halves. If over 18″, split into quarters. White oak bolts used at Wilmington measure 36″ for stave bolts and 24″ for heading bolts; core must be hewn out; minimum face at inner edge 4″

Heading bolts for sugar barrels in the Adirondacks consist of spruce cut in lengths forming multiples of 22″ with a diameter minimum of 6″.

Stave logs for sugar barrels consist of birch, beech and maple, the lengths forming multiples of 32″, with a diameter minimum of 8″.

(l) Bolts for carriage spokes. Material is black or shellbark hickory, white oak, white ash and post oak strictly free from imperfections. Minimum diameter 12″; length 6½ feet, 7½ feet, 8½ feet and so on.

(m) Paper pulp. Logs scale 6″ and upwards; no dead timber. In the State of Maine pulp logs are peeled in the woods.

(n) Veneering blocks. Hardwoods preferred, of the biggest possible diameter, but certainly over 18″ diameter. Blocks from 2 to 6 feet long.

(o) Tannin extract wood. Length of wood 5 feet, split from logs 10 inches and over in diameter. Wormholes allowed. Fibre must be absolutely sound. A cord consists of 160 cubic feet.

Higher price for peeled wood. Butt logs preferred. Cutting of saw logs out of same tree forbidden.

(p) Fuel cordwood. Advisability for piles to contain one cord. Weight of pieces should be such that one man can lift them easily. Splitting facilitates the process of drying; in pine wood it also prevents rotting.

# CHAPTER III. TRANSPORTATION.

## § VIII. TRANSPORTATION WITHOUT VEHICLES ON LAND.

The following methods of such transportation are en vogue:

A. Carrying stove wood, pulp wood, extract wood etc. on men's shoulders, a method of transportation very largely used abroad and in India. Carrying distances abroad range up to one-eighth of a mile. In India railroad ties are carried by the Hindoos over much longer distances.

"Stretchers" are sometimes used where slope is not steep, or "timber carriers." Morley Bros.' lughooks are used in America.

At Biltmore firewood is carried to the roads over an average distance of 150 feet on men's shoulders.

B. Dragging logs by human force where vehicles or water is near and where produce does not weigh over a ton. The front end of a log is placed on a tray (lizard) to prevent it from boring into the ground.

Barked or peeled and well trimmed logs are easily dragged. Silviculturally, dragging is, of course, inferior to carrying of wood products.

C. Rolling logs by human labor is necessary almost everywhere. Peavy, cant hook and "krempe" are used for the purpose.

On a slope of about 15 %, after removing obstacles, logs will roll easily.

Shingle blocks, stovewood blocks and other short round wood may be spanned in a frame. This method of transportation badly damages young growth and trees left standing.

D. Shooting logs down chutes.

A dell in the slope of 30 % or more is often filled with (peeled) logs; then the top logs are shot down the dell over the other logs below.

Three kinds of chutes proper may be distinguished:

I. Pole chutes;
II. Board chutes;
III. Earth chutes.

I. Pole chutes have been largely used in the United States, costing about $300 a mile. They are said to last from seven to ten years and should have the following grades:

| | For long logs. | For short logs. | For railroad ties. |
|---|---|---|---|
| Dry chute | 15-20% | 25-35% | 26% |
| Iced chute | 4- 8% | 8-12% | 6% |
| Watered chute | 3- 6% | 5- 8% | |

Heavy curves must be avoided and the outside of light curves fixed with a number of "saddle logs."

Pole chutes consist of a trough made of four to six poles. The pole chute is about three feet wide and requires cribs or yokes for a foundation where it is not laid on the ground.

Water, ice and soap are used for lubrication. Chutes made of hardwoods are said to run smoother than those made of conifers, owing to the greater elasticity of conifers. Where the grade is light, poles should be peeled and hewn on the inside. The grade of inlet must be very steep; the outlet should open into a pond. Frequently, when the job of chuting is finished, the poles or ties composing the chute are shot down themselves, thus dissolving the chute.

II. Board chutes, which are frequently movable, consist of 1-inch or 2-inch boards. They are used in carrying firewood and other short stuff down slopes of 25% to 35%. The rougher the produce, the steeper must be the grade and the wider and smoother must be the trough. Sprinkling is required during dry weather, sanding during wet spells.

III. Earth chutes. These resemble snaking roads of a steady grade, which grade must be:

(a) Where snow or ice crust is available, 8 to 10%.

(b) Where split cross ties are used, laid about 5 feet apart; for logs 16 feet long or longer, from 10½ to 18%.

(c) Where dry earth is used, 25% and over.

Road poles must be used on the valley side, especially so in curves, and bridges must cross all the gullies.

E. "Roping" is a method employed for moving long and heavy logs in the "Black Forest." A rope is fastened at the small end of the log to a ring dog and swung once or twice around the stump of a tree nearby. The log is started by the "krempe," and its speed is controlled by loosening or tightening the loop around the tree. When the rope is run out it is fastened anew, after stopping the log, to a tree lower down on the slope. The best slope is about 35%.

F. Snaking logs or skidding logs.

I. Attachment by chains 12 to 16 feet long and 1/3 inch to ½ inch thick ending in dogs. When a chain link breaks, a "cold shut" is put in its place (cost $3 per 100 for ½-inch chain). For smaller logs skidding tongs are used in place of dogs, attached to main chain by three rings, swivel and hook, and costing, per dozen, about $50.

In the case of horses, stretchers are used to prevent the traces from hurting their legs.

On muddy soil, the nose of the log is frequently placed on a tray, or a lizard, or a triangle.

Snaking dogs are usually hand made and should be driven by a maul. Plain points on dogs seem to be preferred. Logging dogs 10 inches to 12 inches long are quoted at $15 per dozen.

II. Animals. For long distance hauling, mules or horses are preferred to oxen. Ox harness is rarely used. In the South three yokes form a "team" usually, the chains running from yoke to yoke. Leaders (oxen) require special training. The teamster manages the yokes of oxen by shouting, applying the whip as little as possible.

III. Roads for skidding or snaking.

(a) Uphill grades must be strictly avoided; even level stretches are disastrous. The grade depends on the season of usage. Where ice and snow are available 1% or 2% are ample. On dry rocky ground 50% is the maximum. On the average, for "Biltmore" conditions, 20% seems best.

(b) Curves must be strictly avoided, especially "inside curves" skirting a gully. Herein lies the greatest difficulty of snaking road building in sections where the mountain slopes are deeply gullied.

(c) In the Appalachians the surface of the road is 2½ to 3½ feet wide and road poles laid on the valley side prevent the logs from jumping the road.

Swampy and moist places are corduroyed lengthwise with the road. Creeks must be bridged. It must be kept in mind that one bad spot in a snaking road requires the use of additional teams over the entire length of road.

Regular troughs made of two strong poles resting on cross ties are used in Pennsylvania, where grade is deficient and distance long. Out West cross ties 7 feet apart are placed on the road. In both cases long log trains are formed. It is claimed for such trains that the pull or strain on the animals is evened or equalized, some logs sliding down hill while other logs of the same train overcome impediments.

(d) Means of lubrication are: Sprinkling with water; laying cross ties or length ties; peeling of logs; greasing the ties.

Means of braking the logs are: Sprinkling earth, sand, hay and branches on the road; throwing chains on the road, or tying chains around the logs.

(e) Snaking distance. Snaking distances range up to one mile (usually), averaging about one-third of a mile. Where many logs, say 30,000 board feet of logs or more, must be transported on the same road over an average distance greater than one-third of a mile, other means of transportation are usually preferable to snaking.

In the Appalachian hardwoods the expense for 1,000 board feet snaked over ½-mile amounts to about $4. In the Adirondacks skidding costs 40c to 50c per 1,000 board feet, the distances being short, since the logs are merely skidded to the skidways arranged alongside the sleigh roads.

G. Drums.

I. Hand drums or winches are used for yarding logs and especially for hoisting logs up hill on steep inclines, the distances not exceeding 300 feet. G. B. Carpenter quotes single "drum grabs," weighing 275 pounds and having 2 tons power, placed in strong oak frames, at $27. Power capstans might be used for the same purpose.

II. Drums with horses as motive power are used in eastern Tennessee for hoisting logs up to the rim of the sandstone plateaus.

III. Steam power is now universally used out West in connection with drums known as "Bull Donkey" and "Donkey" engines. Skidding or snaking roads are usually dispensed with. Steel cable (¾-inch plow steel) is used on the drums. The distance of haulage should not exceed 1,200 feet. The main cable is pulled out by a

½-inch endless cable ("tripline") running into the district to be logged over a number of tackle blocks. Zigzags can be made by using tackle blocks on the hauling line as well. One engineer and one fireman are all the crew required in addition to two loaders. Frequently the engine loads logs on railroad cars at the same time.

The engine's cylinders are about 8 inches by 10 inches. Engines are moved from place to place by their own power. Price for an engine f. o. b. Biltmore is $1,400. Boilers are of the upright type. The wire cable is usually made of 6 strands, each containing 19 wires, wound around a hemp center. Running cables should never be galvanized. The proper load of a cable is only one-fifth of the breaking strain in tons. Steel ropes (cables) have twice the strength of charcoal iron ropes. One-inch steel wire cable costs 19c a foot, weighs about 1½ pounds per foot and has a breaking strain of 33 tons. Its proper load is 6 tons only. Silviculturally this method of steam logging is objectionable.

### § IX. WATER TRANSPORTATION.

Logs or lumber are driven loosely or floated in rafts.

A. Loose driving is a method used in eastern America for short logs, pulp wood and firewood.

Specific gravity of material driven must be reduced below 1.00. Heavy species might be deadened a year before driving, like teak in India, to attain this end, provided that attacks from fungi or insects, on the deadened trees, are not to be feared.

Under favorable conditions, where the creeks are narrow and well watered, no special arrangements for driving are required.

I. Splash dams. The proper site for a splash dam is the rocky narrows of a water course below a broad bottom of little fall, or else at the outlet of a natural lake.

Large splash dams must be placed on rock foundations. The expense of building increases at a cubic ratio with the height of the dam.

Splash dams built in tributaries are preferable to dams in the main creek, provided that they can be filled quickly enough.

A system of dams of first, second and third importance is frequently formed.

The distance of effectiveness of a dam depends on the size of the water reservoir, the width of the water course below the dam, and the rapidity of its fall. On "Big Creek" in Pisgah Forest the distance of effectiveness was four miles.

Splash dams meant to be permanent must be built of stone and are exceedingly expensive.

The usual splash dam consists of timber cribs filled with rock and joined by logs laid crosswise. The front of the dam must be slanting and is covered with a double layer of boards. The gateway of the dam must allow of rapid drawing (or opening) of the basin. The gates are either constructed barn door fashion, held in place by a strong key and lever, or consist of (vertical) piling, the individual piles to be lifted by a crowbar or drum. Half-moon-shaped gates are used in the Lake States and in the Adirondacks.

The smaller the water supply and the greater the pressure the tighter must be the gate.

The expense of a splash dam of the first order is from \$1,000 to \$2,000. A timber splash dam lasts from six to ten years.

Frequently additional small gates are made to give a "fore-water," meant to loosen the logs in the creek below the dam. The actual splash rather presses the logs down the creek, instead of floating the logs.

II. Dams in the creek bed itself are sometimes required to raise the water in a shallow section.

III. Before driving begins, the creek bed must be cleaned out by removing old log jams, leaning trees and huge boulders. Sharp bends of the creek must be cut through, so as to straighten the creek bed.

IV. Fixtures along the bank of the creek are required to prevent logs from getting smashed when striking a bluff; from being thrown on the bank in a curve of the creek; from destroying the banks, and further to prevent the spread of water and loss of force, where a splash is expected to overrun adjoining flats.

Such bank fixtures consist of:

Pole cribs filled with rock, the poles lying solid, pole to pole, toward the creek, or of inclines of poles laid horizontally, supported by strong uprights from behind, or of alternating layers of fascines and stone, joined together by strong piling driven into the ground; or, finally, of brush laid on the sloping bank and irregularly covered with rock.

V. The bottom of the creek is sometimes paved with stone or poles laid lengthwise, where the bottom consists of clay. This is especially necessary in artificial channels or canals dug through sharp curves of the creek, or dug close to the connecting booms.

VI. Booms.

(a) European booms are rake booms, the teeth of the rake formed by strong palings.

The tops of the teeth are connected by strong timber bars, which are held in place by stone cribs.

These booms are stretched diagonally across the river. The logs or wood are merely diverted by the boom and forced into an artificial side canal ending in a reservoir near the mill or depot.

A gridiron or sieve, filtering the river at a waterfall and retaining the wood on the gridiron, has been used in the Tyrol by the Bavarian Government for many decades.

(b) The American boom consists of two sections, an upper shear boom spanning diagonally across the stream and a lower storage boom stretching for miles along the river bank, where the water is quiet and the current slow. Both booms are floating booms consisting of one or two strings of prime logs, the logs joined by anchor chain. The booms are kept in place either by wire cables ¾-inch to an inch in diameter or by stone filled cribs. It is advisable to have the storage boom consist of independent sections so that the breakage of the boom empties one section only.

Frequently several mill concerns form boom companies.

The logs are lifted out of the booms by "jack works" or "log hoists."

VII. Driving and splashing must be considered a backwoods method, applicable to very cheap stumpage. It is not practiced on the Pacific coast, where we have very cheap stumpage, owing to the size of the logs and poor water facilities. Where there are plenty of natural lakes, in a coniferous country as in the Adirondacks, Michigan and Minnesota, the method continues to be practiced.

Splashing is the more advisable:

(a) The smaller the specific gravity of timber.
(b) The shorter the logs.
(c) The lower the stumpage price.
(d) The more reliable the rainy season and the gauge of the river.
(e) The better the natural conditions are at the dam sites, in creek bed and at boom site.
(f) The poorer the natural conditions are for railroad building and wagon road building.
(g) The less land owned by other parties is traversed by splashed logs.

(h) The more saw timber improves while being bathed in running water.

(i) The longer the distance.

(j) The more inclined the log owner is toward taking risks and the less affected he is by reduced fertility along the river bank.

Remarks: In the pine woods of the South in olden times ditches were dug about three feet wide, connecting stumpage with swamps and rivers.

The outlay per 1,000 board feet in splashing and driving is from 50c to $1 (for manual labor only).

River driving of cord wood at Biltmore from the upper end of the estate to Asheville, inclusive of piling at the boom, costs 50c per cord.

B. Rafting.

Loose logs are tied into rafts at a place where the flow of the creeks and rivers begins to be more gentle.

Only rarely are rafts used in connection with splash dams on very rapid streams. (Black Forest.)

According to the size and species of logs, rafts are formed either with the logs lying with the stream (longleaf pine rafts etc.), or with the logs lying square to the stream. In this latter case the length of the logs should not exceed eighteen feet. Square rafts consist usually of hardwood logs.

I. Logs with the stream.

(a) The logs are joined into raft sections, each section one log long; the narrow end of the log points down stream; joining usually by rope, cable or chain; ring dogs or eye dogs are used, or wooden pins in connection with auger holes.

(b) At the tail section the rear ends of the logs are allowed to spread fan shaped.

(c) The raft is directed by long rudders (sweeps), by brakes (poles which are pressed against the bottom of the river) and pike poles.

(d) The width of the raft and the tightness of binding depend on rapidity of the stream, span of bridges to be passed, sharpness of bends of river and width of river bed.

Remarks: Ring dogs for rafting weigh about 1½ pounds, are four inches long and have a 2½-inch ring, through which rope is run. Price 10c apiece.

Eye dogs are made of ½-inch round iron, are six inches long and cost 6c per pound.

II. Logs square to stream.

(a) The ends are joined by cross poles, sometimes imbedded in the logs and held in place by pins driven into auger holes, or by chain rafting dogs, consisting of two small wedges joined by two rings and five links of chain. Weight 2½ pounds. Price 12c.

(b) The logs must have about equal length. Species not floatable otherwise are tied up with floaters of pine, yellow poplar, cottonwood and linden.

In the Mississippi two oak logs are floated by three cottonwood logs.

(c) Such rafts are naturally stiff and cannot be used on rapid streams. The narrow and wide ends of the logs should alternate so as to keep the sections straight.

C. Flumes.

Flumes resemble chutes made of boards. They must be water tight. They are largely used on the Pacific coast.

I. A V-shaped cross section has proven best. Side boards are equally long, about 16 feet, in double layers. Angle of the V = 110°. Top width is 3 feet to 4 feet.

II. An even constant grade of from 1% to 3% is necessary, also slight curves and large water supply, which is often obtained from artificial reservoirs. High trestle bridges are sometimes required.

III. The main flume has a number of tributaries. A crew is stationed along the flume; special attention is given to the inlets of tributaries. Patrol trails along the flume.

IV. The fluming of logs is said to be unsuccessful. In the West, anyhow, the size and weight of the logs would prevent fluming. Nowadays either planks or heavy dimension stuff, to be resawn at the outlet of the flume, are sent down. Only coniferous lumber is flumed.

The lumber in the flume forms one continuous chain; this arrangement prevents the lumber from sticking and catching at the side walls of the flume.

V. Famous flumes are those at Chico—Sierra Nevada range (40 miles of flume), the flume of the Bridal Veil Lumber Company and the Great Madeira flume, all in California. The last is 54 miles long and has a daily carrying capacity of 400,000 feet of lumber. It cost only $5,000 per mile.

The scarcity of water in California is the greatest obstacle to the continuous use of flumes.

D. Water transportation over lakes and sea is effected in the following way:

I. In the "fiords" of the Pacific coast, logs standing upright are chained together so as to form a stockade in which the other logs are similarly placed, filling it tightly. Such stockades hold about half a million board feet of lumber at a time and form a seaproof raft, pulled to the mill by tugboats.

II. Logs chained together in the form of a cigar-shaped raft after various patterns have proven a failure. These rafts were taken from the Oregon and Washington coast to San Francisco, being launched like a steamboat and towed by tugboats. To judge from newspaper reports cigar-shaped rafts of boards have proven a success.

The steamship companies consider cigar-shaped rafts a great danger to navigation.

III. In carrying logs across the lakes in the Adirondacks and Lake States, light ring booms are used. The logs are placed in such booms at "the landing" and are rafted (driven) to the outlet of the lake either by wind, current or tugboat.

### § X. TRANSPORTATION ON LAND WITH VEHICLES.

A. Sleighs and sleds.

I. Hand sleighs, home made, very light, are frequently used abroad at grades of 10% and more. Man sits in front of load and directs with legs and side brake. On steep slopes such sleighs are used in summer as well. Fifty cubic feet is an average load for one man. The workman carries his sleigh back uphill on his shoulders for the next load.

Sleighing roads for summer sleighing frequently have cross ties at short intervals to be kept greased at slight grades.

II. The American sled has nothing in common with the European sled. A team of horses is always used for motive power.

The sleigh, or sled, consists of two sets:

The front set has a tongue of rock elm or oak and a front roller in which the tongue is set. Runners are 7 feet to 9 feet long, 3 inches to 4 inches wide, shod with ½-inch steel shoes or cast iron shoes either below only or both above and below; they are either slightly convex or flat. The front of the runner should be of a natural curve or crook, not hewn. Material is white oak. The cross beams, either ironed or plain, rest in saddles or nose plates with knees.

The "back roll" of the hind set is coupled to the front set by chains attached to the center of the front cross beam. There is no tongue to the hind set.

III. Log binders are used on loading chains to take about half a foot of slack out of the chain, unless the same end is secured by poles and the twisting of the binding chain.

IV. The usual load of a sleigh is five tons, while a wagon carries only two tons on an average.

The actual load depends on distance, grade and condition of road. In the Adirondacks about 2,000 board feet form a load; in Ontario 1,500 feet of white pine or spruce.

V. Sledding roads are constructed in the Adirondacks at an expense of $25 to $150 per mile. The sledding distance is said not to exceed three miles, usually. The teaming expense is about 10c per 1,000 board feet per mile.

The relative distance of snaking and sledding depends on configuration and density of stand. Sledding roads are preferably built on swampy soil. Heavy grades require a heavy outlay for sanding; insufficient grades a heavy outlay for icing. Carelessness in surveying sleigh roads is extremely expensive in short, mild, snowless winters. The modern lumberman surveys his roads with instrument in hand, completing them before snowfall.

To begin with, an empty or lightly loaded sleigh is run over the road to mark and set the track.

B. Transportation on two-wheelers.

I. High wheelers, wheels 7 feet to 10 feet high, are used in the pineries of the South, in California, and to a certain extent in the Lake States for hauling coniferous logs of 1½ feet average diameter and of extra long length.

Logs are loaded underneath the axle, either by using the tongue as a lever or with the help of a second axle having the form of a winch (Southern method).

Logging distance in the South not to exceed half a mile, average one-quarter of a mile. Expense $1 per 1,000 board feet.

The best makes are:

Bodley Wagon Co., Staunton, Va.; Snyder Wagon Co., Shreveport, La.

Prices from $100 to $150.

II. Low wheelers, usually called "Bummers," the wheels consisting of a solid tree section held by iron rims 1½ feet in diameter. The top of the axle is even with the top of the wheels. The tongue is only six feet long and merely used as a lever in loading. The bummer is pulled by chain attached to point of tongue and is loaded by placing axle parallel to log close to center of log, with the tongue standing perpendicular, the log being fastened to the axle by short chains and dogs.

High and low wheelers are used on undulating ground for downhill pull on soil free from rock, swampy places, debris and brush.

C. Log wagons. Log wagons are entirely used for transportation in the old country, where the forests are traversed by a network of well graded stone roads. Wagons are always handmade, of light weight and carry up to 17 tons of logs.

In carrying long boles, the front and hind trucks are separated. Steep curves can be made if the rear ends of the logs are fastened underneath the axle of the hind truck.

The American wagon has a track width, from center to center of tire, of 4 feet 6 inches or 5 feet.

Wheels are usually made entirely of white oak. The wood is well seasoned. The tire is 3 inches, 5 inches and over. Front and hind wheels usually equally high—2 feet to 3½ feet. Eight wheelers are now widely advertised.

Skeins are preferably made of welded steel instead of cast, 3 inches to 5 inches in diameter.

Steel axles have not proven a success, owing to difficulty of repairs in the backwoods. Bolsters should reach to or over the top of the wheels.

The reach should allow of changing distance between front and rear set.

Main requirements are:

I. Strength.
II. Possibility of repairs in the woods.
III. Low point of gravitation.
IV. Ease of loading.
V. Ease in turning.
VI. Light weight of wagon itself.

Prices for log wagons range from \$80 to \$200 according to carrying capacity. Weight from 800 to 1,800 pounds. Carrying capacity 1½ to 5 tons.

D. Traction engines. Traction engines are largely used abroad and have proven very successful recently in the South African war. In freighting lumber from mill to city or depot they are used in the United States on a small scale, since stone roads seem to be a prerequisite; loose sand, deep mud or swamp are impracticable for traction engines. In Pennsylvania four-wheelers costing \$1,500 for a 16-horsepower compound engine and able to climb 12% grades and to turn 30 feet curves have proven a failure, since the use of traction engines plows the roads during rain.

In the California mountains, where drouth prevails during six months of the year, the three-wheelers manufactured by the Best Company, of San Leandro, Cal., have been largely and successfully introduced. Very high wheels and broad tread cause little injury to the route traveled. The boiler is a combination of upright and horizontal, concentrating weight on the driving wheels and preventing water and fuel from dropping back from the pipes on steep grades. Engines are said to be able to climb 30% grades and to climb over logs, brush, stone etc. Front wheel is for steering only, with front drum for skidding logs by wire cable.

E. Pole roads. A statistic of 1886 finds in the United States over 2,000 miles of pole roads, using over 400 locomotives and over 5,000 trucks.

I. The rails are made of straight, preferably coniferous poles, sufficiently trimmed to fit the double flange of the truck wheels. On suitable soil no ties are required, the rail being gradually pressed into the ground.

Sawn rails, preferably consisting of several layers of boards, must be used in curves of the pole road and are still largely used near mills on steep and short grades.

II. Trucks. The wheels should not turn with the axle. An oval concave rim said to be inferior to a flat rim with heavy flanges.

Each wheel has about 2 inches room for side play. The reach should turn like a swivel in hind and front set, allowing all wheels to stay on the track.

III. All lumbermen now agree that pole roads are impracticable for locomotives. On sawn rails locomotives are still used, however, when prices of steel are high, grade steep, distance short and use intended for a short while only. Sawn wooden rails do not allow of heavy loads and, consequently, seem unadvisable just for logging by steam engines.

F. Forest railroads.

I. Portable forest railroads.

In American lumbering portable railroads are little used. The sections of which portable railroads consist are necessarily light and, consequently, unfit for the heavy traffic of American lumbering. In Europe the sections are usually 6½ feet long, have 2½ feet gauge and weigh 80 pounds. Steel ties are preferable at the ends so as to have the joints supported by ties. The sections are joined by a hook arrangement without being bolted together.

Usually the sections are merely laid on wood roads. Motive power is supplied by gravity, men or horses. Wheel flanges usually on both sides of the rail. Rail sections of trapeze form are sometimes used in building curves. Bridge switches are preferable to split switches.

In the wood yard at Biltmore sections of wooden rails were used, the ties being replaced by iron rods. The top of the rail was shod with a strip of ¼-inch iron, the ends joined by hook and pin, and by hole and pin.

Steel sectional tracks of 2½-inch gauge are manufactured by the C. W. Hunt Co., New York. The trucks used have the wheel flange outside. Curves and switches are ready made. Straight sections are 6 feet to 20 feet long.

II. Stationary track.

(a) Grade. A proper survey is very essential. For steep grades (over 7%) a soft rail is required. Grades of 11% are feasible on straight track for locomotives having eight drivers.

High percentage for very short distance is, however, permissible.

Logging roads in the South have grades running up to 15% for uphill traffic, obtaining the necessary impetus by a corresponding downhill grade. The expense of maintaining the track and the frequency of accidents render steep grades highly expensive.

The standard railroads have never over 4% grade.

(b) Curves. The minimum radius of curves depends on gauge of track; distance between axles of front and hind trucks; length of timber to be carried and grade in the curve. Curvature is measured by the subtended angle, the (secant) chord of which is 100 feet. Standard railroads do not allow of an angle exceeding 10%.

In curves, to relieve the increased friction, and, further, to prevent the trucks from jumping the track, owing to centrifugal force, three remedies are required:

1. Lessened speed and reduced grade.

   In practice for standard gauge of 56½ inches, for each degree of curvature the grade is released by 0.02%; for narrow gauge by 0.03%.

2. The outer rail is elevated for standard track by ½-inch for every degree of curvature; for 36-inch gauge (usual narrow gauge) by 1-3 inch for each degree of curvature.

3. The track is widened in curves by 1-16 inch for every 2½ degrees of curvature.

(c) Rails. The form is usually the T rail. Grooved rails, flat rails, rails inclined toward center of track etc. are freaks merely. In logging railroads the rails are often fastened lengthwise on sawn or hewn stringers, which arrangement allows of light rail. The gauge is measured inside the tops of the rails if the flange is inside, and outside the rails if the flange is outside. If the wheel has a double flange, measure from center to center of rails.

In lumbering operations, the standard gauge (56½ inches) is generally preferred, since heavier loads can be taken and since the rolling stock can be disposed of more readily at the end of operations. Of the narrow gauges 36 inches is best, since the odd gauges prevent ready exchange of addition to and sale of rolling material.

In mountainous sections narrow gauge is preferred. Here the expense of wide gauge track is too high, since it requires flatter curves, smaller grades and largely increased outlay for roadbed.

In standard lumbering operations a heavy (56 pounds) rail is now preferred, the up-keep of track being cheaper, the bed for the track being less expensive and fewer ties being required for the heavy rail. Light rails are so twisted, after short use, that they cannot be sold at second hand. For 36-inch gauge a rail weighing 16 pounds to 20 pounds is best.

Rule for number of tons of rail required per mile:

1. Tons of 2,000 pounds.

   Multiply the weight of the rail by 7/4 and you obtain the number of tons required per mile. For example, 20-pound rail x 7/4 = 35 tons.

2. Tons of 2,240 pounds (after which rails are usually sold).

   Multiply weight of rail by 11/7 instead of by 7/4.

   The price per ton of rail (steel) varies from $25 to $35.

   The interdependence between locomotive's weight and minimum weight of rail permissible is given by the following equation:

   $$\frac{w}{n} \times 8 = r$$

   wherein *w* stands for weight of locomotive in tons; *n* stands for number of drivers; $r$ stands for minimum weight of rail in pounds.

Estimates of cost of track, exclusive of rolling stock and bridge arrangements, vary from $1,300 to $4,300 per mile for easy grading. One-half of the expense in this case is for rails, spikes and splice joints (fish plates).

The grading and laying of track costs from $300 to $1,000 per mile for easy grading; and cross ties cost about as much.

Estimate of cost per mile for

| | |
|---|---|
| 1. Sixteen-pound steel rail, requiring 25 tons of rail @ $32 per ton.$ | 800.00 |
| 1,780 pounds of 3½x⅜ in. spikes at 2c per pound.............. | 35.60 |
| 357 splice joints at 20c.......... | 71.40 |
| 2,640 cross ties at 15c............ | 396.00 |
| Grading and track laying........ | 500.00 |
| Total ...................... | $1,803.00 |
| 2. 40-pound steel rail, requiring 63 tons of rail at $30 per ton...... | $1,890.00 |
| 4,690 pounds of 4x½ in. spikes at 2c a pound................... | 93.80 |
| 357 splice joints at 40c each...... | 142.80 |
| 2,640 cross ties at 25c each...... | 660.00 |
| Grading and laying track........ | 1,000.00 |
| Total ...................... | $3,786.60 |

(d) Cars.

Cars consisting of two trucks, of two axles each, form the rule.

The trucks should be very low and should have short distance between axles where curves are heavy. For narrow gauge tracks, special trucks are constructed costing from $50 to $80. While steel trucks are more satisfactory in the old country, in America trucks with wooden framing and wooden bolsters are usually preferred, owing to greater ease of repair far from factory.

The bearings are frequently outside as well as inside the wheels, so as to have the frame supported at eight instead of at four points of the two axles. The bolsters, swiveled on the frame, are very frequently much longer (wider) than the axles.

The weight and capacity of logging cars should be as follows:

| | Weight in lbs. | Capacity in board feet. |
|---|---|---|
| 4 wheel cars ......... | 3,000 lbs. | 1,000 b. ft. |
| 4 wheel cars .......... | 4,000 lbs. | 1,500 b. ft. |
| 4 wheel cars .......... | 5,000 lbs. | 2,000 b. ft. |
| 4 wheel cars .......... | 6,000 lbs. | 2,500 b. ft. |
| 8 wheel cars .......... | 6,900 lbs. | 2,000 b. ft. |
| 8 wheel cars .......... | 8,400 lbs. | 3,000 b. ft. |
| 8 wheel cars .......... | 9,600 lbs. | 4,000 b. ft. |
| 8 wheel cars .......... | 11,000 lbs. | 5,000 b. ft. |

(e) Locomotives.

Logging locomotives are manufactured by the
Baldwin Locomotive Works, Philadelphia;
H. K. Porter, Pittsburg, Pa.;
Climax Mfg. Co., Corry, Pa.;
Stearns Locomotive Co., Erie, Pa. (for Heissler geared locomotives).

The price is practically independent of the gauge, being influenced more by horsepower.

Four driving wheels are usually sufficient. On steep grades, six wheels and, on very steep grades, eight wheels are used.

The resistance to be overcome by the tractive force is:

1. Gravity, which increases in exact proportion to steepness of grade expressed in per cent. Thus it is always 20 pounds per ton for each per cent.
2. Friction of the journals and of the wheel flanges against the rails, which depends, aside from curvatures, on quality of the track and of rolling stock. It is at least 5 pounds per ton; it amounts to 6½ pounds for first class equipment; to 20 pounds to 40 pounds for bad equipment, and in extreme cases it rises to 100 pounds.

Tractive force is understood to be one-fifth of the weight, in pounds, on the driving wheels, expressed in tons.

For instance:

Weight on driving wheels 25,000 pounds, divided by 5=5,000 pounds; and 5,000 tons is therefore the tractive force of the engine.

The hauling capacity of an engine is: tractive force divided by the sum of the frictional and gravity resistance, both expressed in pounds, deducting the weight of the locomotive from the quotient. For example:

Weight of locomotive on 4 driving wheels = 20,000 pounds. Tractive force is 4,000 tons.

*First case*—Frictional resistance 8 pounds per ton, grade level. Then the hauling capacity equals 4,000 tons over 8 (friction) plus 0 (gravity) minus 10 = 490 tons.

$$\frac{4000}{8+0} \text{ minus } 10 = 490 \text{ tons.}$$

*Second case*—Frictional resistance same as above, grade 1%.

$$\frac{4000}{8+20} \text{ minus } 10 = 133 \text{ tons.}$$

*Third case*—Frictional resistance 8 pounds. grade 2%.

$$\frac{4000}{8+40} \text{ minus } 10 = 73 \text{ tons.}$$

The cost of hauling logs on a standard railroad, per carload of 40,000 pounds, amounts to $5 for distances of one to fifty miles, and to $6 for distances of fifty to one hundred miles.

Porter's catalogue gives the cost of hauling as ranging from 30c to 60c per 1,000 b. ft. for a logging distance of from five to ten miles. At Chicora, Ala., two standard trains provide daily, together, 100,000 b. ft., coming from a distance of about eight miles.

Small (narrow gauge) locomotives haul from 60,000 to 120,000 b. ft. per week over distances of from five to ten miles.

Where grades are not excessive, a locomotive should cover daily 60 to 80 miles, the hauling distance varying from 2 to 10 miles.

G. Mono rail.

The mono rail portable railway is a French invention (Caillet) and has been tried to a limited extent in India.

It consists of one rail only, resting on steel sole plates at intervals of a few feet, and is laid down direct on the surface of the ground. Rails are joined together by scabbard fish plates. The trucks have two low wheels, grooved at the rim, the carriage hanging between the wheels a few inches above the rail. Cars are balanced by a telescopic rod and kept in balance, like a bicycle, by the motive power itself, which consists of an animal hitched in a frame alongside of the carriage.

The mono rail system might be applicable in the transportation of bark, cordwood and minerals.

H. Cable way logging.

The logs are suspended from a cable and are not dragged on the ground.

I. On steep slopes, the grade being 35% to 50%, the logs slide down by gravity, being suspended from two trolley blocks held apart by a strong rod or pole, about 15 feet long. At the upper end of the cable, curved iron rails lead, like a bridge switch, onto the cable. The cable is kept tight by heavy drums, over which the cable runs at the ends. It is said to wear out in about eight years.

The speed of the block carriage is regulated by manila rope, wire or light wire cable, and the empty block carriage is carried backward by the same rope without any motive power other than that of a loaded block carriage going down hill. Proper switches allow the empty block carriage to pass the loaded one at a half-way point. The price of 1-inch wire cable is about 19c per foot.

In Switzerland lines two miles long are found, without any supports. In the Hartz Mountains supports are given every 700 feet and the expense is $800 per mile for entire equipment.

In Oregon and western North Carolina short cable conduits of this character are in successful use, and in India (in the Himalayas) the most extensive plants of this character are said to exist.

II. In swamps of the Atlantic coast, where railroading is difficult, the system of the Trenton Iron Co. and of the Lidgerwood Manufacturing Co. have been tried which move the block carriage holding the logs in suspense over a cable either by steam power or by electricity.

(a) In case of steam power, the engine is placed either on a scow swimming in the swamp, in the river, in the logging canal cut by powerful dredges, or on a railroad car, the logging outfit costing about $7,500 per mile (including lateral rig), consisting of:

One-inch carrying cable and double traction rope;

Double block carriage with differential hoist and log grip;
Brackets, supporting the cable;
Steam engine with hoisting drum;
Lateral hauling-in rig, by which logs are dragged to the main carrying line over distances running up to 1,000 feet.

(b) In case of electric power, the outfit, costing $6,200 per mile, consists of:
One-inch carrying cable and ½-inch single current rope, which is swung thrice over a grooved sheave;
Generating machines and 20-horsepower steam engine;
Carriage, including the log support and the motor with sheave, which has a speed of six miles an hour.

I. Loading arrangements are required, wherever vehicles are used, except for bummers.

I. Loading on wagons.

(a) Sliding logs from a higher bank onto vehicles. Only one layer can thus be loaded conveniently.
(b) Rolling logs up an incline, either with peavies or rope, the top of the incline resting on the tops of the wheels.
(c) A (drum) winch in front of wagon, incline behind wagon, pulling logs up by rope.
(d) Tackle block attached to a tree, the wagon standing between the tree and log; the end of rope attached to outside wheel and the free end pulled by animals.
(e) The skidway scheme. Trained horses running on prepared track opposite the skidway. Two poles leading from skidway to wagon; rope running from outer wheel of wagon under and around the log and back over the wagon to the horses.
(f) A jack, consisting of a gear wheel and a toothed iron rod.
(g) German lever arrangement.

II. Loading on railroad cars.

Additional methods.

(a) A huge tripod and Weston's differential hoist.
(b) A drum and wire cable rig, the loading cable running over a tackle block suspended over track.
(c) Cranes or derricks as used on the harbor docks, a special make of which is known as the

"Decker log loader." There is some mechanical difficulty in constructing loaders of a sufficient angle of leverage.

§ XI. CHOICE BETWEEN THE VARIOUS SYSTEMS OF TRANSPORTATION.

Conditions governing the selection of means of transportation are:

A. Topography. Steep grades make it advisable to send products down by their own weight, so that animals and vehicles need not reascend the grade.

B. Periodicity of rain and snow fall (West Virginia for spring rains, Lake States for snow fall, California for spring drouth) invite the use of means relying on water supply, on layers of snow, on dry soil.

C. Rocky soil entails blasting expenses and thus bars railroading and road building, Wet or swampy soil requires an artificial surface on which means of transportation are placed.

D. Existence of drivable creeks and rivers, their grade, rockiness, curves, steadiness of flow, the spans and number of bridges crossing them, the danger or help expected from freshets are factors bearing on the advisability of water courses used as means of transportation. Electric power derivable from water falls might be used as motive power in days to come.

E. Availability of building material in the forest, especially the price of rails and ties and quality of stone etc.

F. Total amount of stumpage, and stumpage per acre to be carried away from a given locality annually, periodically or once only.

G. Maximum weight and size, also average weight and size of pieces to be handled.

H. Price and effect of day labor and prospects of changing prices under the influence of labor laws and socialistic legislation.

I. Relative price of team labor and of manual labor. The ratio between price of hand labor and team labor abroad is 1 to 8. In this country it is 1 to 2½; in Lake States even less, viz., 1 to 2.

J. Condition of existing public means of transportation; roads, railroads and navigable rivers.

K. Laws relative to rights of way and relative to damage inflicted on outsiders in the course of transportation, i. e., by splashing logs; raising water level of lakes and thus destroying trees etc.

L. Mileage of the various links forming the chain of transportation and speculation as to the building of additional public links of transportation.

M. Silvicultural considerations, or choice between conservative and destructive lumbering.

Donkey engines are the destroyers of any second growth left on the ground and should be used only in clear cutting.

High two wheel logging carts are used abroad to save young growth.

N. Possibility and amount of damage to logs and loss of logs in course of transportation. Loss of bark. Loss of sap-wood. Deterioration by fungi and insects. Theft. Loss of interest on value of logs.

O. Regularity and reliability of means of transportation.

P. Possibility of using the means of transportation for purposes other than carrying forest products (access to mines and farms; passenger traffic; supplies for lumber camps; use of snaking roads as fire lanes, patrol trails, sport trails).

Q. The general political and economic condition of the country (settled or unsettled); the possibility of financial surprises.

# Part III. Manufacture of Wood Products.

## CHAPTER IV. FOUNDATIONS OF MANUFACTURE.

### § XII. THE AMERICAN FORESTER AS A LUMBERMAN.

In the old country, a large portion of the products grown in the forest go to the holders of prescriptive rights (easements). The balance is sold either under private contract or at public auction or under sealed bids.

In France, standing stumpage is sold, while in Germany the trees are dissected, at the owner's expense, into assortments required by the local manufacturing trades.

Usually, in the old country, the raw products of the forest are not refined by the forest owner. The forest industries are in the hands of parties who do not own or control an acre of woodland.

In Canada, timber leases or timber limits are sold at public auction. The purchaser pays, aside from the auction price, an annual rental (so called ground rent) and, further, for every 1,000 feet b. m. cut, a specified royalty. Neither ground rent nor royalty is object of the auction sale.

On the forest reserves of the United States auction sales are meant to form the main method of disposal of forest products, exceptions being made only in the interest of local residents.

The private owner of woodlands in the United States, and his forester, is and will be compelled to be a wood manufacturer for many a year to come.

The lumberman need not be a forester; but the forester must be a full fledged and experienced lumberman. Woe to conservative forestry in the United States if the forester, satisfied to give theoretical advice, fails to devote to lumbering and manufacture the larger part of his energy!

### § XIII. MOTIVE POWER.

Motive power is supplied by:

A. Actual animal power said to be used in Texas for running portable saw mills.

B. Wind-mills, which furnish an insufficient and unreliable power.

C. Water-mills. The horse power of falling water is:

$$\frac{v \times h \times 62.5}{33000},$$

wherein stands: $v$ for volume of discharge in cubic feet per minute;
and $h$ for height of fall in feet; and
wherein 62.5 represents the weight of a cubic foot of water and 33,000 equals one horsepower per minute.

For example, if cross section of a race is = 2 sq. ft., water velocity = 660 ft. per minute, height of water fall 30 ft., then the power is:

$$\frac{2 \times 30 \times 600 \times 62.5}{33000} = 75 \text{ H. P.}$$

Water wheels are either vertical, i. e., overshot, breast or undershot wheels, or horizontal wheels, i. e., turbines.

I. Overshot wheel. Effective power is 60% to 70% of possible power. The proper velocity at the circumference is 5 feet per second and at best if it is equal to 0.55 of velocity of water.

In falls of 20 feet to 40 feet and over, overshot wheels are more effective than turbines.

The buckets, framed by the shrouding, should be curved or elbowed and not radial. They should have a capacity three times as large as the volume of water actually carried, a depth of 10 inches to 12 inches and a distance apart, from center to center, of 12 inches.

Ventilated buckets, having holes in the bottom and allowing air to escape, are said to have a better effect.

It is difficult to transform the slow speed of an overshot into the rapid speed required for a circular saw. Transformation is either by countershaft or by cog wheel.

II. The breast wheel has an effective power of from 45% to 65%, is best applied to falls of from 5 feet to 15 feet and to a discharge of from 5 to 80 cubic feet per second. While in the overshot the water works by weight only, it works in the breast wheel largely by impact.

The velocity of wheel should be such as to fill the buckets to 0.5 or 0.6 of their volume. The buckets here are usually called blades and must be ventilated.

The wheel runs in a curb or mantle, formed by the inclined and cased end of the sluiceway.

The distance of the blades, from center to center, should equal the depth of the shrouding, both being from 10 inches to 15 inches. The clearance between the curb and the shrouding must be at least half an inch.

"High breast" wheels are semiovershot and "low breast" wheels are semiundershot wheels.

The "flutter" wheel is a low breast wheel of small diameter and high speed. It is largely used in western North Carolina for saw-mill purposes where water is plentiful and fall about 12 feet.

III. Undershot or current wheels have an efficiency of from 27% to 45% only and are usually kept anchored in rapid streams, so as to be independent of water gauge. No buckets, but long blades instead.

The diameter of the wheel is from 13 feet to 16½ feet; usually 12 blades, the depth of which is 3 feet to 4 feet. The blades should be completely submerged when passing underneath the axle.

IV. Turbines have an efficiency of 60% to 80%. The water does not work by weight, but by impact, pressure, reaction and suction.

The speed is much higher than in vertical wheels and hence is well adapted for circular saw mills.

A turbine, however, is badly affected by variations of water supply and suffers from debris and sand and ice. The effect of the water is greatest when the turbine is entirely under water, the flow of water filling the curved channel completely.

Turbines are:

(a) Outward flow turbines, water fed from near the center.

(b) Downward flow turbines, water fed and pressing from above.

(c) Inward flow turbines, water fed from the perimeter.

(d) Reaction turbines, working after the principle of a lawn sprinkler.

(e) Impulse turbines, principle of flutter wheels.

Modern turbines are worked both by impact and reaction and, if possible, by suction.

A 9-inch turbine, furnishing 14 horsepower, costs $250, plus $100 for setting it in masonry.

The advantages of water mills are: no fuel, no fireman, no engineer, no explosion, less insurance, possibility of using dust and slabs for stable bedding, laths etc.

Disadvantages are: usually small power, small speed and small capacity. Power less controllable, less reliable than steam power and not portable.

Small capacity does not justify a large outlay for good sawmill machinery.

D. Steam mills.

For circular saws, the number of horsepower required is about = 1/3 the diameter of the saw. For example, a 48-inch circular saw requires 16 horsepower. Ten horsepower are said to manufacture 5,000 b. feet daily in circular sawmills, and 30 horsepower will cut 30,000 b. feet daily. Every additional horsepower should increase the capacity by 1,000 b. feet.

In large mills each horsepower ought to manufacture 1,000 b. feet; in small mills only 500 b. feet.

Boilers in common use are designated as:

I. Internally fired boilers, when firebox and waterbox are comprised by one and the same steel shell; so all portable boilers and all locomotive boilers.

(a) Cornish boiler: large flues below and return flue above water through entire length of boiler.

(b) Lancashire boiler: divided flue below and divided flue above water through entire length of boiler, so as to even the draft when firing, and so as to strengthen the broad heating surface.

(c) Galloway boiler: like Cornish but V-shaped tubes beset the boiler proper, thus increasing the heating surface and strengthening the flue.

(d) Locomotive boiler: firebox surrounded by a waterleg on all sides, excepting at the grate below. A bank of small tubes carries gases to an "extension" or "smoke box" in front of smoke stack.

II. Externally fired boilers: masonry firebox underneath boiler which is traversed by a large number of tubes. Gases pass first to combustion chamber at rear end and then through tubes back to front.

To II belongs the water tube boiler, with inclined tubes, a horizontal top vessel and vertical tail tubes, creating a continuous circuit of water.

(a) Pointers about boilers.

1. Twelve square feet of heating surface of boiler furnish one horsepower.
2. Each nominal horsepower requires one cubic foot or 7½ gallons of water per hour.
3. Mud drum at base of boiler to receive impurities deposited by water. Where no mud drum exists, boiler should be blown off weekly through a bottom valve (mud cock).
4. Steam and water capacity must be sufficient to prevent any fluctuation in pressure or water level.
5. A large water surface (horizontal versus upright boilers) prevents steam from bearing water particles along. Usefulness of dome is doubtful as a means to secure the return of watery particles to the boiler.
6. Water should occupy three-quarters of boiler space.

Water space should be divided into sections, an arrangement improving the circulation of water and reducing the severity of any explosion.

7. Modern boilers are tubular boilers, which have the largest heating surface. Diameter of tubes is measured outside, including metal.
8. Combustion chamber should allow of full combustion of fuel and gases. Draft area should be one-eighth of grate area. Return flues pass the gases to the entrance of the combustion chamber.

   Heating surface should be as nearly as possible at right angles to the current of escaping gases.
9. Very best water gauges, safety valves, injectors and steam gauges are prerequisites. All boiler fixtures should be readily accessible.
10. Safety valves must be tried once daily. The water level should be controlled by gauge cocks, glass gauges alone being unreliable.
11. Cold water should not be fed directly into boiler and should never come in direct contact with the boiler metal. Steam injectors will not lift hot water as well as cold water.
12. Steam pressure gauge must stand at zero when pressure is off.
13. In case of low water and danger of explosion, cover fire with wet earth.
14. If fire is fed from mill refuse, steady heat can be retained only with boilers of large water capacity. The larger the boiler the greater the fuel economy.

(b) Pointers about engines.

1. Horsepower of engines is:

   Sectional area of piston in square inches times pressure times velocity in feet over 550.

   Deduct 10% to 20% for friction.

   Pressure on the piston is not much over one-half of pressure in the boiler (60%).

2. Interdependence between size of cylinder and horsepower actually developed is approximately:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Diameter, inches | 8 | 9 | 10 | 12 | 12 | 12 | 14 | 16 |
| Length, inches | 15 | 15 | 15 | 15 | 20 | 24 | 24 | 30 |
| Horsepower | 12 | 15 | 20 | 25 | 30 | 35 | 50 | 85 |

These figures hold good for single cylinder engines and are much lower than the usual catalogue figures. A new engine develops more power than an old one.

3. The flywheel should weigh 600 pounds for every inch of cylinder diameter.
4. Double cylinders are more effective than single cylinders, especially if not hitched tandem fashion, which arrangement, however, allows of using one piston rod.
5. Center crank engines are preferable for small portable saw-mills, since they allow of exchange of flywheel and main driving pulley.
6. Machines cannot get along any better, without care, than horses. Repair and watch the smallest defects. Have the firmest possible foundations. Saw-mill engines are put to the severest possible tests owing to frequent and rapid change of strain.

## § XIV. TRANSMISSION OF POWER.

A. Belts.

Belts in woodworking establishments are always dry and dusty and are kept at a high and often irregular rate of speed. Dust materially decreases the transmitting power of belts.

The heavier the belt the more powerful; use light belt on small pulleys, however, for high speeds.

I. Pointers about belts.

(a) Belt tighteners are required where a belt itself is not heavy and not long enough to cause sufficient sag.

(b) The sag should always be on top and not on the bottom.

(c) The angle of belt against the horizon should not exceed 45°.

(d) Placing one pulley above another requires tight belt, which causes heating in the bearings and destruction to the belt.

(e) Belts should run off a shaft in opposite directions to relieve one sided friction of shaft in bearings.
(f) The pulley must be wider than the belt.
(g) The larger the pulley the greater the tractive power of the belt.
(h) Be sure that the belt does not rub against any beam or other solid object.
(i) Long belts have greater adhesion than short belts because they have more weight.
(j) Belt dressing, to prevent slipping off of belt, is objectionable, because it gathers dust and dirt, except perhaps linseed oil used on rubber belts.
(k) Belts will slip if:
1. The pulleys do not run in one and the same plane.
2. The shaftings are not parallel.
3. The pulley is not as wide as the belt.
4. The belt ends are improperly joined.
5. The speed is too high for the weight of the belt.

II. Kinds of belts:

(a) Leather belts.

Leather belts are either single or double. They come in rolls of from 200 feet to 300 feet, are run with the grain side in and are preferably joined with studs—not by leather laces requiring holes; belt cement is now largely used, laps being joined to a fine edge.

Leather belts must be very well protected from moisture, grease, lubricating oil etc.

Transmitting power of a single belt is only 70% of that of a double belt.

The price of a 7-inch single belt per running foot is $1. For double belt $2.

(b) Rubber belts.

Rubber belts withstand moisture better than leather belts. They are cut from 1/8 inch to 1/4 inch shorter per foot than the circuit on which they run and are run with seam side out.

They are sold as 2, 4, 6 or 8 ply rubber belt, the 4 ply being equivalent to single leather belting and the 6-ply to double leather belting.

The price of 4-ply 7-inch rubber belting is 70c per running foot; of 6-ply, $1.

The ends are joined either by belt cement or by lace leather. The laps are strengthened by a strip of leather on the outside.

Never use metal studs in rubber belts.

B. Pulleys.

Pulleys are made either of iron or of wood.

The adhesion of leather to wood is much greater than to iron, hence greater transmitting power of wooden pulleys.

Split wood pulleys are preferable. The best make is the Dodge split wood pulley, costing for 24-inch diameter and 10-inch face $11.20.

The so called clutch pulleys consist of two wheels wedged one into the other, the inner one loose, the outer one fastened onto the shaft.

Iron pulleys must be absolutely symmetrical.

Pulleys for stationary belts are slightly crowning, while those for shifting belts are straight faced.

Pulleys for heavy work should be placed close to bearings of shaft. The main driving pulley must stand between bearings not over four or five feet apart.

The ratio between the speed of driving and driven pulley is inverse to the ratio of the diameter.

Remarks relative to starting and stopping machinery:

I. Machinery is started by belt tighteners, the belt running over flanged pulleys, by clutch pulley, by tight and loose pulley with shifting belt, by eccentric boxes and by friction pulleys.

II. A rotation is reversed by crossed belts (belt turning 180°) or by paper friction pulleys or by forcing the belt against a driven pulley remaining outside the belt circuit.

III. A rotation is turned at right angles by giving the belt a quarter-twist (90°), or by gear and pinion or by beveled friction.

C. Shafting.

Cold rolled shafting is said to have a torsional strength 30% greater than that of hot rolled shafting.

The usual diameters of shafting in saw mills are from 1½ inch to 3½ inch. The proper speed for shafting is 300 to 400 revolutions and its transmitting power is given as $\frac{D^3 \times R}{80}$ = horsepower.

Herein stands: D for diameter of shafting;
R for revolutions of shafting per minute;
80 for a constant factor.

Couplings by which the sections of shafting are joined should be close to a hanger or a support. They should be easily detachable without driving keys.

Shafting comes in sections usually 12, 14, 16 or 18 feet long.

The section closest to the main driven pulley is often stronger than the other sections.

The bearings should be long, say four times as long as the shafting is thick, and should have self-lubricating devices.

Hangers for 3-inch shafting and of 3-ft. drop cost about $20.

Bearing-boxes are lined with an anti-friction alloy melting easily and offering little friction even under severe pressure. A space of 1/8 inch to 1/2 inch is left between the cast-iron box and the shafting (journal) to be supported. The box is held in a "babbitting jig" while the melted alloy is poured from a ladle. Babbitt metal (invented by Isaac Babbitt) consists of about 96 parts tin, 4 parts copper and 8 parts antimony.

Rules for shafting are:

I. Be sure that line of shafting is parallel to axis of driver.

II. Place all heavy work on the main shaft and close to the main driver.

III. Oil freely and watch bearings constantly. Oil after stopping work, while bearings are still warm.

IV. Drive only minor machinery from gear wheels.

Price of shafting is about 5c or 6c per lb.

§ XV. TECHNICAL USE MADE OF THE TREES, BY SPECIES.

A. Hardwoods.

Cucumber tree: Ox yokes; pump logs; water troughs; cabinet making; ceiling; flooring; invariably mixed with and substituted for yellow poplar.

Tulip tree or yellow poplar: Panels; flooring; molding; clapboarding; sheathing; shingles; siding on railroad cars; interior finish of Pullman cars; coffins; cheap furniture; bodies of carriages and sleighs; sides and bottoms of farm wagon beds; woodenware; bungs; slack barrels and tobacco hogsheads (staves and heading); backing for pianos and for veneers; boxes, especially biscuit boxes and cigar boxes; scroll saw work; wood carving; wood burning; matches; excelsior; paper pulp.

Linden or basswood: Mirror and picture backs; drawers and backs of furniture; molding; woodenware; panels and bodies of carriages; ceiling; wooden shoes abroad; inner soles of shoes; cooperage heading; slack barrel staves; butter churns; laths; boxes; grape baskets; excelsior; parts of pianos and organs; fine carving; papier mache; paper pulp. The flowers are used for tea; the inner bark for coarse cordage and matting.

Holly or ilex: Mallets; edging and engraving blocks; fine cabinet work; painting on wood; tool handles; mathematical instruments.

Buckeye: Artificial limbs; woodenware; paper pulp; wooden hats; fine wood carving.

Maple (western): Furniture; axe handles; frames of snowshoes.

Maple (eastern): Furniture (curly and birdseye); flooring; sugar barrels; mantels; runners of sleighs; peavy handles; ox yokes; axe handles; sides and bridges of violins; woodenware; wooden shovels; shoe pegs and lasts; gun stocks; saddle trees; teeth of wooden gear wheels; piano keys and hammers; wood split pulleys; framework of machinery; ship building; maple sugar; surveyor's implements; plane stocks; wooden types; faucets; clothespins; charcoal; acetate of lime; wood alcohol.

Sumach: Tanning; dyeing and dressing skins; Japanese lacquer work.

Black locust: Police clubs; fence posts; insulator pins; construction work (bridge); turnery; wheelwright work; tree nails (pins); ship building (ribs); hubs of wheels; house foundation.

Mesquit: Fence posts and rails; used extensively for fuel (destructive to boilers).

Black cherry: Fine furniture; cabinet work; interior finish; tool handles; surveyor's implements.

Crabapple: Pipes, mallets; wooden measure rules; tool handles.

Witch hazel: Pond's extract.

Dogwood: Tool handles; spools; bobbins; shuttles; mauls; wheel hubs; machinery bearings; engraving blocks.

Black gum: Heavy (wagon) hubs; rollers in glass factories; mangles; ox yokes; stock of sledge hammers in steam forges; veneers for berry baskets and butter dishes; slack barrels; in cheap furniture, for backing and drawers; barn flooring.

Tupelo gum: Chemical paper fibre; slack barrel staves (rotary veneer cut); wooden shoes and woodenware; the corky root is used under the name of corkwood for bicycle handles and floaters of fishing nets.

Sweet gum: Known in Europe as satin walnut and used for fine furniture and cabinet work, in America for cheap furniture; cheap building lumber; flooring; plug tobacco and cigar boxes; wagon beds; slack barrels; strawberry boxes; veneer cut dishes; coiled hoops; street paving.

Sourwood: Tool handles; machinery bearings; sled runners.

Rhododendron: Bruyere pipes; tool handles; turnery; toys; rustic furniture.

Persimmon: Bobbins; spools; shuttles; tools; golf club heads; plane stocks; shoe lasts; wood engraving. The black heart is cut into veneers and used for ebony.

White ash: Wagons and carriages (poles, shafts, frames); interior woodwork; inner parts of furniture; mantelpieces; sporting goods (bats etc.), oars and gymnastic bars; lances; agricultural implements; tennis racquets; snowshoes; skis; wooden pulleys; barrel hoops; pork barrel staves; baskets; dairy packings (firkins, tubs etc.); tool handles.

Catalpa: Fence posts; railroad ties; telegraph poles.

Sassafras: Light skiffs; fence posts; rails; cooperage; insect-proof boxes; ox yokes. Roots used to make sarsaparilla.

California laurel: Ship building; cabinet work and interior finish.

Elms: Wheel stock, especially hubs; fence posts; ribs of small boats; top spans in covered railroad cars; railroad ties; tongues for sleighs and sleigh runners; saddle trees; flooring; exported for inner lining of boats; butcher blocks and churns (butter); cheese boxes; imitation oak furniture; sugar and flour barrel staves; patent coiled hoops for slack cooperage; agricultural implements; bicycle rims; basket making; gun stocks; frame timber of piano cases; wheelbarrows; hockey sticks.

Hackberry: Fencing; occasionally for cheap furniture; hames.

Mulberry: Fencing; cooperage; in the South for boat building; axe handles.

Osage orange: Fencing; paving blocks; railroad ties; wheel stock; toothpicks; fine mallets.

Sycamore: Furniture; plug tobacco boxes; butchers' blocks; interior finish; beehives (hollow log sections); butter and lard trays; wooden bowls.

Walnuts: Interior finish; furniture; gun stocks; tool handles; cabinet work; boat building.

Hickories: Axe handles; wagon stock, especially whiffletrees; neck yokes; spokes; tongues; felloes; skeins; buckboards; rustic furniture; barrel hoops; screws; mallets; parts of textile machinery; farm implements; wooden rails (top); baskets; bows of ox yokes; boat building; hickory bark for flavoring sugar (to imitate maple syrup).

Oaks (white and burr): Furniture; wagon and carriage stock, especially spokes, felloes, hubs, tongues, hounds, bolsters, sandboards, reaches, brake bars, axletrees, whiffletrees; railroad ties; freight car building (framework); ship building; house building and interior finish; shingles; agricultural implements; bridge building; mining timber; wine, beer and whisky barrels; parquet flooring; staircases; split wood baskets; hogshead and barrel hoops.

Post oak: Fencing; railroad ties; construction; staves; carriage and wagon work; farm implements.

Basket oak: Baskets; cooperage; wheel stock; fencing; agricultural implements; construction.

Chestnut oak: Bark used for tanning; fencing; bridges; railroad ties; substitute for white oak, but objectionable in tight cooperage.

Live oak: Ship building; furniture.

Red oak: Shingles; furniture; interior finish; tight and slack cooperage.

Texas oak: Same as red oak. Said to check less than red oak.

Black oak: Plow beams; furniture; lumber; bark for tanning and quercitrin.

Tanbark oak: In California bark used for tanning.

Chestnut: Tannin extract; coffins; furniture; interior finish; shingles; fencing; railroad ties; sheathing; jacob staff for compasses; bridge building (trestles); telephone poles; backing of piano veneers; slack barrel hoops and sawn staves.

Beech: Wood alcohol; wood ashes; charcoal; shoe lasts; plane stocks; clothespins; handles; wooden bowls; horse collars (hames); parquet strips; flooring; street paving; railroad ties; sugar barrels. Beech furniture made out of veneers of three or four thicknesses, or bent after steaming.

Hop hornbeam: Posts; levers; tool handles; wagon brake; shoes; wedges.

Hornbeam: Used for same purposes as above, and teeth of gear wheels.

White birch: Toothpicks; shoe pegs and lasts; wood pulp; spools; clothespins; screws; flooring; veneers; furniture; bobbins and spindles; wooden skewers; hand-made barrel hoops.

Gray birch (yellow): Furniture (usually mahogany finish); match boxes; wheel hubs; tool handles; buttons; brush backs; shoe pegs; clothespins; sugar barrels; dry distillation for wood vinegar; wood alcohol; charcoal etc.

River birch: Furniture; woodenware; wooden shoes; ox yokes.

Cherry birch (sweet birch): Imitation cherry furniture; ship building; bark distilled for oil of wintergreen.

Oregon alder: Furniture; cigar boxes; mining props and water conduits; charcoal in gunpowder.

Black willows: Osier culture (imported species); pollarded for fascines; the Missouri species for fence posts after thorough seasoning; bats for baseball; a drug, salicylic acid, made from the bark; charcoal for smokeless powder.

Cottonwoods: Boxes; wood pulp and fibre; slack barrels; woodenware; flooring; excelsior; backing for veneers in organs and pianos; matches; cheap building lumber; cheap furniture; wagon beds; turnery; woodenware; fence boards.

B. Conifers.

Incense cedar: Water flumes; fencing; furniture; interior finish; laths and shingles.

White cedar (northern): Posts; fencing; telegraph poles; railroad ties; tanks and buckets; shingles; street paving; boat lining.

White cedar (Southern): Woodenware; tanks; buckets; barrels; telegraph poles and fence posts; shingles; railroad ties; boats; lampblack.

Red cedar (Pacific): Canoes of Indians; interior finish; fencing; shingles; cooperage; tanks; buckets.

Port Orford cedar (Lawson's cypress): Lumber; inside finishing; flooring; railroad ties; fence posts; matches; ship building. The rosin is a powerful insecticide.

Western juniper: Fences.

Red cedar (of the East): Tanks, posts, buckets; telephone poles; cigar boxes; chests; pencils; interior finish.

Bald cypress: Tanks; shingles; doors; house building; interior finish; sashes; blinds; molasses barrels; railroad ties; posts; car siding; flooring and covering; wharf piles.

Big tree: Lumber; fencing; shingles; construction; water conduits.

Redwood: House building and finishing; shingles; fencing; telegraph poles; vineyard stakes; railroad ties; car lining; tanks; coffins.

Yew. In Oregon for bows and fishing rods.

White pine: House building and finishing; boxes and crates; sash, doors and blinds; shingles; backing of fine veneers; excelsior; matches; laths; woodenware; slack barrels; framing of machinery; furniture; patterns for casting metals; ship masts; baled shavings for filtering gas, bedding for horses, packing for crockery.

Sugar pine: Same uses as white pine; cooperage; shakes (large board shingles).

Lodge-pole pine: Cheap lumber; mining timbers; railroad ties; used where other timber is not available.

Loblolly pine: Common lumber and cheap veneers, usually mixed with "echinata"; shingles; house building purposes altogether; mining timber; boxes; rice and potato barrels; laths.

Shortleaf pine (echinata): Same use as above; boxes for naval stores.

Table mountain pine: In Pennsylvania used for charcoal.

Longleaf and Cuban pine: House building; dimension stuff; shingles; tanks; flooring; interior finish; railroad ties; railroad bridges; car sills and framework of cars; furniture; sash, doors and blinds; framework of machinery; mining timber; ship building; masts; wagon tongues and beds; naval stores.

Scrub pine (Virginiana): In Kentucky, for lumber.

Jeffrey's pine: Coarse lumber; mining timber.

Bull pine (ponderosa): Lumber; railroad ties; mine props; shingles; boxes; slack barrels.

Jack pine (divaricata): Ties and piling; cheap lumber; boxes; laths.

Norway pine: Lumber generally; ship building; construction; flooring; masts; piles of wharves; covering; lining; siding; flooring and sills of railroad cars; railroad ties.

Eastern spruce: Chemical fibre and paper pulp (down to 5"-diameter); matches; excelsior; construction; posts; railroad ties; fresh-water ship building; clapboards; flooring; ceiling; stepladders; sounding boards (from butt logs); oars; spars; wharf piles; telegraph poles; toys; wood type; butter buckets; slack cooperage; wooden thread (for mattings); chewing gum; vanillin. In Europe spruce bark is used for tanning.

Engelmann's spruce: Used in Colorado for common lumber.

Tideland spruce: Lumber; construction; outer finish; woodenware; paper pulp.

Hemlock: Coarse rat-proof lumber; dimension stuff and construction; shingles; railroad ties; fencing; paper pulp; bark for tanning.

Douglas fir: All building lumber; construction; railroad ties; trestle bridges; piles; car sills; ship building; masts; mining timber; bark sometimes used for tanning.

Firs: Paper pulp. In the East for corduroying. In the West for local lumber; packing cases; cooperage; interior finish; mine props.

Tamarack (Eastern): Fence posts; telegraph poles; ship's knees; railroad ties.

Tamarack (Western): Posts; railroad ties; car construction; dimension stuff.

C. Tropical and subtropical timber.

Yucca: Paper pulp and fibre for ropes; pincushions.

Eucalyptus: Street paving; railroad ties; mine props; piles; ship building; wagon making; orchard paling.

Mangrove: Bark very rich in tannin.

Palmetto: Wharf piles; pincushions; brushes.

Lignumvitae: Bowling balls; blocks for pulleys; fine interior finish and furniture; railroad ties in Panama.

Teak: Ship building and flooring; railroad cars; street paving.

West India cedar: Racing boats; cigar boxes.

Olivewood: Turnery; inlaying; furniture; backs of hair brushes; wood carving. The fruit yields the best oil for table use.

Quebracho: Tanning; paving; railroad ties.

Lancewood: Fishing rods.

Mahogany: Furniture; ship building; pianos; fine interior finish.

## § XIV. TECHNICAL QUALITIES OF THE TREES.

A. Botanical structure of the trees.

I. Botanical structure of hardwoods.

The cells forming the woody tissue are:

(a) Ducts (pores, vessels) formed by the resorption of the partition walls in a vertically running string of cells. Such ducts are characteristic of hardwoods.

(b) Sclerenchyma, cells of heavy walls and small lumina, usually forming long fibres.

(c) Parenchyma, cells of thin walls and large lumina, frequently containing grains of starch.

Medulla or pith is found in the central column, in the primary, secondary, tertiary rays and (rarely) in medullary spots (birch). The central pith is:

Heavy in ash, maple, elder, catalpa;

Triangular in birch, alder;

Quinquangular in hornbeam.

Broad leaved species are called "ring porous," if the spring wood of the annual ring contains strikingly large pores, or else "diffuse porous," if the ducts are evenly distributed over the entire ring. Sapwood and heartwood are merely distinguished by a difference of color, caused by incrustations of pigments, lignin, tannin etc., in the walls of rings formed a number of years before. The number of years elapsing before incrustation takes place is small in catalpa, chestnut, locust; and larger in yellow poplar, white oak, walnut where it is about thirty or forty years old. Beech, maple, basswood etc. do not form any heartwood.

GENERIC STRUCTURE OF HARDWOODS.

| Medullary Rays. | Ringporous always with heart. | Inner pores more numerous, always with heart. | Diffuse porous. Pores absolutely even With heart. | Without heart. |
|---|---|---|---|---|
| Scarcely visible. | Castanea<br>Robinia<br>Fraxinus<br>Hicoria | Rhamnus<br>Rhus<br>Syringa | Juglans<br>Pyrus malus<br>Sorbus<br>Salix<br>Liriodendron | Alnus<br>Pyrus communis<br>Crataegus<br>Betula<br>Aesculus<br>Populus |
| Visible. | Ulmus<br>Morus<br>Ailanthus | Prunus | | Tilia<br>Acer<br>Corylus<br>Carpinus<br>Ilex |
| Broad. | Quercus<br>Vitis<br>Rosa | Sambucus | | Platanus<br>Fagus |

II. Botanical structure of softwoods.

(a) The tissue of softwoods is more homogeneous than that of hardwoods. It is mainly formed by tracheae.
The cell walls formed in early spring are thinner and the lumina formed in early spring are larger than those formed in summer.

(b) Parenchyma is found in the medullary rays and around the rosin ducts.

(c) Ducts of the form found in hardwoods exist only close to the central pith column.

(d) The medullary rays are very fine (microscopic), usually only one cell wide and about a dozen cells high. The lowest string of cells in the ray is usually formed by tracheae (exception—red cedar).

(e) Rosin ducts are not cells merely, but, unlike the ducts of hardwoods, hollow tubes, the walls of which are formed by parenchymatic cells. These ducts are running horizontally as well as vertically in picea, pinus, larix, pseudotsuga.
The tissue of the genera abies, taxus, juniperus, thuja, tsuga, chamaecyparis etc. lacks the ducts.

(f) Heartwood and sapwood of conifers are distinguished merely by a difference in color, due to incrustations of rosin in the inner heartwood rings. Pinus echinata has, usually, about thirty sapwood rings. Spruces, firs and hemlocks have no heartwood. Heartwood is conspicuous in the pines, red and white cedars, lawson cypress, yew, larches and douglas fir.

B. Chemical qualities of wood.

I. The walls of the tissue are formed by cellulose ($C_{12}H_{20}O_{10}$) and by lignin ($C_8H_{12}O_5$).

Cellulose transforms, entirely or partially, in the very year in which the cell is built, by incrustation and reduction into lignin. If a branch or a seedling does not enjoy enough light during summer to allow of thorough lignification, then that branch or seedling is necessarily killed by the winter frost.

II. Wood and bark contain on an average 45 % (weight) of water. Conifers contain less water than broad-leafed species. The percentage varies irregularly with the seasons and with the precipitations.

III. Other substances found in the woody tissue are:

(a) In the sap and medulla—albumen, starch, sugar, oils.
(b) In the cell walls—tannin, rosin and pigments.

IV. The specific gravity of pure wood fibre is 1.56.

C. Outer qualities, or qualities discernible by eye, touch or scent.

I. Texture. The texture is fine or rough according to the ease with which parts composing the tissue can be distinguished.

The texture is:

(a) Very fine—yew, box, holly, persimmon.
(b) Fine—pear tree, hornbeam, black gum.
(c) Pretty rough—spruce, fir, magnolia, cottonwoods.
(d) Rough—cherry, sycamore, maple.
(e) Very rough—oak, elm, locust, beech.

II Color. Color is an advantage in the furniture trade and a disadvantage in the manufacture of paper. The heart of seasoned wood is always darker than the sapwood.

Tropical species are particularly rich in color.

Wood exposed to air changes its color more or less visibly. The heart of yellow poplar changes to a dark brown. Alder changes from white to red. Ash from white to light violet. Mahogany from brown to black. Walnut similarly.

III. Gloss. Gloss is due to evenness, number and size of medullary rays.

Shining species are maple, ash, elm, beech.
Medium shining are oak, alder, hornbeam.
Dull are peach, pear, conifers.

Quarter sawing increases the gloss.

IV. Odor. Odor is important for the use of wood in the package industry. The strong odor of wood is usually lost in the course of seasoning. The following species retain, however, a characteristic odor: Cherry, birch, sassafras, red cedar.

D. Inner qualities, or qualities discernible by mechanical tests.

I. Specific gravity.

(a) Pure wood fibre forms in fresh wood, with broad leafed species of temperate climates, about 35 % of the entire weight, while conifers show an average of about 25 %.

(b) Air dried wood still retains from 10 % to 15 % of water. If the dry kiln reduces the percentage of water below that figure, the hygroscopicity of the wood will speedily cause it to return.

(c) Factors influencing specific gravity of air-dried wood within the same species are:

1. The width of the rings, in ring porous hardwoods and in conifers forming heartwood.
2. The incrustations of rosin, tannin and pigments in the heart.
3. The age of the tree.
4. The decay of the fibre.
5. The section of the tree, since roots are very light, butt logs heavy, bole fairly light and branches fairly heavy.

In the case of the diffuse porous hardwoods and of conifers destitute of heart, no rule can be given relative to specific gravity of inner and outer layers, of wide and narrow rings.

(d) Air dried lumber has, on an average, the following weights:

| Species— | Specific gravity. | Weight of 1,000 ft. b.m. |
|---|---|---|
| Turkey oak, hickory, service-bush | over 0.75 | over 4,000 lbs. |
| Ash, white and red oak, locust, beech, hornbeam, hard maple, pear tree | 0.70-0.75 | about 3,750 lbs. |
| Elm, soft maple, apple tree, sycamore, birch | 0.60-0.70 | about 3,400 lbs. |
| Horse chestnut, chestnut, tulip tree, alder, larch, longleaf pine | 0.55-0.60 | about 3,000 lbs. |
| Yellow pine, douglas fir, spruce, fir, willow, cottonwood | 0.45-0.55 | about 2,600 lbs. |
| White and sugar pine | under 0.45 | about 2,200 lbs. |

(e) Rules.

1. Specific gravity times 5,200 equals the weight of 1,000 feet b. m. of sawn lumber. Reason—1,000 superficial feet of water one inch deep weigh 5,200 lbs.

2. Specific gravity times 8,000 times cordwood reducing factor equals the weight of a cord of wood. Reason—128 cubic feet of water weigh 8,000 lbs.; a cord of wood contains from 20 % to 85 % of wood, the balance being air.
3. Specific gravity air dry times 5,200 times 23 equals the weight of 1,000 feet b. m. in the log. Reason—a green log has about 10 % bark, about 27 % of water, to be removed by drying, and loses 33 % for slabs and kerf in band sawing. Hence the weight in 1,000 feet b. m. air dried and band sawed lumber is only 0.9 times 0.73 times 0.67 of the weight of a log scaling 1,000 feet b. m. Doyle. The weight of a green log is 2.3 times the weight of air dried lumber obtainable from it by the band saw. For broad-leafed species and for circular saws the figure is higher than for conifers and band saws.

(f) Heavy planks do not dry as thoroughly as thin boards.

(g) Weight determines freight and customs charges. Also adaptability to packages, floatability in flumes and rafts and possibility of loose driving.

Lumber freight rates from Asheville, N. C., are:
29c per 100 lbs. to New York.
23½c per 100 lbs. to Philadelphia.
12½c per 100 lbs. to Atlanta.
18c per 100 lbs. to Washington.
14c per 100 lbs. to Norfolk.

Lumber freight rate from Portland, Ore., to Chicago is about 50c per 100 lbs.

Steamer rate to Europe from Norfolk is 14c per 100 lbs. of lumber.

The freight rate on logs for 50 miles is at least $5 per carload; for 100 miles at least $6.

II. Hardness.

By hardness is understood the resistance of the fibre to axe and saw worked vertically to the fibre.

Factors of hardness are:

(a) Density; wide rings in oak and narrow rings in pine increase the hardness.

(b) Incrustation; heartwood is harder than sapwood.

(c) Moisture contents; dry wood is, on the whole, harder than green wood. With some broad-leafed species of loose tissue (willows and cottonwoods), however, moist wood is tougher and therefore harder as well.

(d) Frost increases the hardness.

SCHEDULE OF HARDNESS.

| Hard. | Medium. | Soft. | Very soft. |
|---|---|---|---|
| Hickory | Ash | Chestnut | White pine |
| Dogwood | Oak | Tulip tree | Sugar pine |
| Sugar maple | Elm | Sweet gum | Sequoia |
| Sycamore | Beech | Douglas fir | Paulownia |
| Locust | Cherry | Fir | Willow |
| Hornbeam | Mulberry | Yellow pine | |
| Persimmon | Birch | Larch | |
| | Sour gum | Linden | |
| | Longleaf pine | Horse chestnut | |
| | | Hemlock | |
| | | Cottonwoods | |
| | | Spruce | |

III. Cleavability or fissibility.

Cleavability is the resistance of fibre to axe, saw and wedge, worked lengthwise in the direction of the fibre. Radial cleavage is usually by 50 % to 100 % easier than tangential cleavage (except in black gum).

Factors of cleavability are:

(a) A straight, long, elastic fibre.

(b) Heavy and high medullary rays.

(c) Straightness of growth.

(d) Branchiness.

(e) Moisture (very green and very dry wood splits best).

(f) Frost (reduces the cleavability).

(g) Hardness and softness (extremely hard and extremely soft wood splits badly. This rule holds good only in hardwoods).

SCHEDULE OF CLEAVABILITY.

| Hard to split. | Medium to split. | Easy to split. |
|---|---|---|
| Black gum | Oak | Chestnut |
| Elm | Ash | Pines |
| Sycamore | Larch | Spruce |
| Dogwood | Cottonwood | Fir |
| Beech | Linden | Cedar |
| Holly | Yellow poplar | |
| Maple | Hickory | |
| Birch | | |
| Hornbeam | | |

IV. Pliability.

Under pliability we combine flexibility and elasticity.

(a) Flexibility; wood which is easily bent without breaking is flexile (flexible). Softwoods are naturally less flexile than hardwoods.

Flexibility depends on:

1. Toughness and cohesive force of fibre.
2. Moisture, which increases it very much.
3. Heat, which increases it.
4. Age of tree, inasmuch as young shoots are tougher than old wood.
5. Impregnation, natural as well as artificial,

checks flexibility. (Heartwood less flexible than sapwood.)

6. Root wood more flexible than stem wood.

Remarks: Heat and moisture as a means to increase flexibility are applied in these industries:

Cooperage; for bending staves and hoop poles.

Carriage works; for bending poles, shafts, felloes, top frames, seats etc.

Furniture; bent wood furniture.

Ship building.

Veneer peeling.

Basket work.

Manufacture of musical instruments.

(b) Elasticity and flexibility are not always found in the same piece of wood. On the contrary, qualities which increase flexibility frequently reduce elasticity, and vice versa. Elasticity is the force with which an object resumes its old shape when pressed out of shape and released.

The factors of elasticity are:

1. Long and straight fibre.
2. Narrow rings in conifers.
3. Dryness (moisture reduces elasticity).
4. Frost (which destroys elasticity).
5. Excessive contents of rosin (which increases the elasticity).

SCHEDULE OF ELASTICITY.

| Very elastic are: | Less elastic are: |
|---|---|
| Yew | Cottonwood |
| Larch | Birch |
| Fir | Maple |
| Locust | Elm |
| Chestnut | Alder |
| Hickory | Walnut |
| Osage orange | Yellow pine |
| Red cedar | Yellow poplar |
| Lancewood | Beech |
| Spruce | |
| White pine | |
| Ash | |
| Oak | |

V. Strength.

Strength is resistance to:

(a) Tension; to which timber is usually not exposed. (Yoke of oxen pulling the cart by the pole.)

(b) Compression (arches, pillars, scantling).

(c) Torsion (shafts, screws, axles).

(d) Shearing.

(e) Transverse straining (beams, girders, joists).

Factors of strength are:

1. Specific gravity.
2. Soundness of tissue.
3. Freedom from branches.

Timber, like any other material, should never be loaded to over one-fourth of its indicated strength.

Transverse strength is always proportioned to length of girder; to width of girder; and to the square of the depth of girder. It is *the* quality of timber which is most required in timber used for building purposes.

VI. Hygroscopical qualities.

(a) Timber changes form, coherence and volume with greater or lesser ease under the influence of moisture, applied in gaseous or liquid form. Hence shrinking, swelling, warping, checking, cracking, casehardening and working.

(b) Water invariably saturates the cell walls; in addition, it may or may only partially fill the lumina.

(c) Sapwood invariably contains more water than heartwood.

(d) Rate of dryness depends on the species, looseness of tissue, dimensions of object to be dried, presence or absence of bark cover in logs, preceding treatment by floating, deadening, steaming, prevalence of sapwood or heartwood, season of year, exposure to wind, climate etc.

(e) Boiling and steaming reduce the hygroscopicity and produce, consequently, a more even shrinkage.

(f) The evaporation from the cross section bears to that of the tangential and to that of the radial section the ratio of 8 to 1 to 2.

(g) In the dry kiln, temperatures of 160 degrees to 180 degrees Fahrenheit are gradually produced. Drying is accomplished by hot air, steam and moving air.

Conifers stand the dry kiln process much better than hardwoods. The better qualities of hardwoods undergo air drying before being kiln dried, especially so in wagon, furniture and barrel factories.

The dry kiln saves insurance and interest on large stocks of lumber and allows the lumberman to rapidly fill pressing orders for lumber.

(h) Wood is least permeable for water in the direction of the tangent or vertically to the medullary rays —a fact important for tight cooperage.

1. Shrinkage.

It is least along the fibre; it is up to 5 % along the radius and is up to 10 % along the tangent.

Shrinkage of over 5 % of green volume

occurs in walnut, linden, beech, elm, chestnut, birch.

Shrinkage of 3 % to 5 % occurs in oak, maple, sycamore, ash, cottonwood, yellow pine.

Shrinkage of 2 % to 3 % occurs in spruce, larch, fir and white pine.

A large percentage of rosin, narrow annual rings and light specific gravity reduce shrinkage within the same species.

2. Checking.

It depends on the rapidity of the drying process; on size and dimension of object; on peeling of logs; on homogeneity of tissue.

Checks are often of a temporary nature, disappearing when the inner layers are as dry as the outer layers.

Hardwoods check much worse than softwoods; and rift sawed or quarter sawed lumber checks less than bastard sawed lumber.

Remedies against checking of logs are: Winter cutting; strips of bark left near the end of peeled logs; felling with the roots and leaving the crown on the undissected bole; deadening; "S" shaped iron clamps driven into logs; boards nailed onto the ends of the logs; earth cover at the ends of the logs; red lead painting for export logs.

Remedies against checking of lumber are: Quarter sawing; slow air drying under sheds; veneer sawing; steaming or boiling; sticks placed close to the ends of tiers in lumber piles.

Checks are radial since the tangential shrinkage is greatest. The so-called wind (or ring) shakes are not caused by the hygroscopicity of the timber; they are merely a form of disease of timber, due to frost, heat, fire or insect plagues interfering with the radial cohesion of adjoining rings.

3. Swelling, warping and working.

These phenomena are due to reabsorption of water after drying. The swelling is greatest tangentially. Heartwood warps less than sapwood, and conifers warp less than hardwoods. Boards obtained from close to the slab warp worst of all.

Remedies against working are steaming; varnishing; forming boards by gluing fine veneers one upon another; allowing framework of doors to be sufficiently grooved for receiving the panels.

VII. Duration of wood.

(a) Duration of wood depends on:

1. The surrounding conditions; i. e., tropics or arid deserts; presence of insects (ants and fungi); contact with clay, limestone or sandy soil; immersion in water (toredo); exposure to atmosphere; moisture conditions; presence of preserving matter (salt water, copper mine water).

2. The natural qualities of wood, especially the presence or absence of rosin, tannin and other preservatives; the specific gravity; the percentage of sapwood; the susceptibility to fungus and insect diseases. Locust, red cedar, sequoia, bald cypress, are less subject to such diseases when dead than when alive.

(b) Remedies against destruction are: Impregnation or painting; charring the part imbedded in the soil; winter cutting; change of species when replacing ties; kiln drying and steaming and smoking; raising buildings high above ground.

(c) Bulletin No. 10 gives the following data for the average "life" of ties:

| | |
|---|---|
| White and chestnut oak, | 8 years |
| Chestnut, | 8 " |
| Tamarack, | 7—8 " |
| Cherry and walnut, | 7 " |
| Elm, | 6—7 " |
| Longleaf pine, | 6 " |
| Hemlock, | 4—6 " |
| Spruce, | 5 " |
| Red and black oaks, | 4—5 " |
| Ash, beech, maple, | 4 " |
| Locust, cypress, | 10 " |
| Red cedar, | 10 " |
| Redwood, | 12 " |

(d) Schedule for lumber:

| *Very durable.* | *Durable.* | *Short lived.* |
|---|---|---|
| Walnut | Ash | Beech |
| Locust | Larch | Sycamore |
| Sequoia | Yellow pine | Birch |
| Cedar | Spruce | Linden |
| White oak | Fir | Cottonwood |
| Catalpa | Yellow poplar | White pine |
| Sassafras | Douglas fir | |
| Chestnut | | |
| Longleaf pine | | |

VII. Heating power.

Heating power or fuel value bears a direct ratio to specific gravity air dry. All wood fibre having the specific gravity 1.56, equal air dry weights of our common species furnish equal heat. On the other hand, light weight means greater inflammability and a quicker heat, which naturally lasts for a short time only. The heating power of hard coal is to that of lignite and to that of wood as 5.2 : 4.3 : 1. In other words, 5.2 lbs. of dry wood yield as much heat as 4.3 lbs. of lignite or as 1 lb. of coal.

Influencing factors are found in the following moments:

(a) Presence of rosin increases the heating power by about 12 %.

(b) A cord of wood containing 45 % moisture has, after German experiments, the heating power of half a cord of air dried wood. After Sargent, the discrepancy is not as great. One cord of green wood contains 250 gallons of water, and the calories of heat required to convert this large amount of water into steam are lost for heating purposes.

(c) Unsound wood has a reduced heating power, the cell walls being decayed.

(d) Chestnut, and to a certain extent larch and spruce, are despised in open fires owing to crackling and emission of sparks. Black gum is despised because it is difficult to split and therefore difficult to season. Hornbeam, birch and alder are said to furnish a particularly quiet flame.

(e) Schedule of the heating power of wood per cord:

| *Best.* | *Good.* | *Moderate.* | *Bad.* |
|---|---|---|---|
| Hickory | Oak | Spruce | White pine |
| Beech | Ash | Fir | Alder |
| Hornbeam | Birch | Chestnut | Linden |
| Locust | Maple | Hemlock | Cottonwood |
| Heart pine | | Sap pine | |

IX. Miscellaneous technical qualities of wood.

(a) Adaptability to planing and molding; varnishing and polishing; painting and gluing.

(b) Nail holding power, which is said to be excellent in chestnut, white pine and hemlock.

(c) Twisted growth, which is frequent in chestnut, Italian poplar and horse chestnut. Certain twists are due to a hypertrophical growth of the tissue and are highly prized by the trade under the names of birdseye maple, curly poplar, curly walnut, curly cherry and curly ash etc. It is impossible to say whether a standing tree is "curly" or not. Sap-sucking woodpeckers may start the "freak."

(d) Knots check the value of lumber. A standard knot is a sound knot, the diameter of which varies according to local inspection from 1¼" to 1¾". Dry, dead and unsound knots throw a board into the mill cull pile. Usually, the knotty part of a log is sawn into dimension stuff. The core of a log, even in yellow poplar, necessarily shows knots, since there is no height growth without simultaneous formation of side branches.

(e) The discoloration of the inner layers of certain species which are not classed as heartwoods (beech and maple) is a disease often found in old trees and causes rejection for certain applications in the trades (impregnation).

# CHAPTER V. MANUFACTURING INDUSTRIES.

## § XVII. THE SAW MILL.

A. The saw.

Three kinds of log saws are used:

I. Straight saws, viz:
- Vertical straight saw;
- Gang saws;
- Horizontal frame saw.

II. Circular saws, viz.:
- Solid tooth single saw;
- Solid tooth double saw;
- Inserted tooth saw.

III. Band saws, viz.:
- Single cutting band saw;
- Double cutting band saw.

I. Straight saws.

(a) Single vertical straight saw. At the toothed edge this saw has a thickness of from 5 to 10 gauges. Its blade is 8 inches wide and at least twice as long as the log diameter.

A short blade yields the finest work, since it can be spanned more tightly.

The gauge along the back should be finer than the gauge along the cutting line.

The saw can cut any thickness of trees.

The saw cuts only by the down stroke while the log is moved against the saw during the up stroke.

The saw is spanned in a guide frame and is given as many inches inclination toward the log as the feed of the carriage per stroke amounts to. If the saw were not inclined all the work would be done by the lowest teeth.

The usual set is still the spring set and not the swage set, although the latter is sure to be superior.

Usually the ends of the boards are not sawn through but are held together by the "comb," which is finally split with the axe.

In filing mill saws, obtain sufficient pitch of teeth to prevent saw from kicking out of the cut. Too much pitch, however, causes chattering.

Gullets must be kept carefully rounded.

(b) Gang saws. They are used in large mills for inferior logs.

The best make is Wickes Bros.,' Saginaw, Mich. Enormous stone foundations are required.

The saw frame has an oscillating motion which presents the saw to the cut in an easy raking sweep, forcing each tooth to do its full share of the work.

Gang saws are not fed from a carriage. The logs are run through feed rolls, feeding the logs into the saws.

Blades are 6 to 10 inches wide and of 8 to 16 gauge.

Horsepower required is said to be for friction, 3 horsepower; for first blade 4 horsepower, and for every additional blade ½ horsepower more.

Where log heaps (up to 12 logs) are run through the gang saw, the logs are slabbed by a "rosser" or "log siding machine," so that the logs can be placed one upon another.

(c) Horizontal frame saw. It is used to cut fine veneers and valuable timber. Its advantage lies in the fact that very little weight rests on the saw, that the saw can cut on both trips (to and fro), that high speed may be applied and that a thin gauge can be used.

The best make is Kirschner's, Leipzig, Germany.

II. Circular saws.

(a) Power.

Ten horsepower should manufacture 5,000 b. feet per day; 20 horsepower should manufacture 10,000 b. feet per day; 30 horsepower should manufacture 30,000 b. feet per day, and each additional horsepower should add 1,000 b. feet to amount cut. This amount depends on size of logs.

Five horsepower is required for a 20-inch to 30-inch saw; 12 horsepower for a 30-inch to 40-inch saw; 15 horsepower for a 48-inch to 50-inch saw; 25 horsepower for a 50-inch to 62-inch saw.

(b) Right hand and left hand mills.

If the carriage is to the left of the observer while the saw runs towards him, the mill is a left hand mill, and vice versa. A right hand saw is screwed to the arbor by a left hand nut and is usually driven by a left hand steam engine.

Center crank engines can be used for either right or left hand mills.

(c) Speed.

The proper speed at the rim of any circular saw is 9,000 feet per minute.

There should be a speed indicator to control the saw's speed. It costs 75c.

If the power is too light to run the mill at standard speed, portable mill men usually increase the speed of the engine, putting a larger receiving pulley on the saw mandrel.

(d) Proper qualities of a saw.

1. The usual thickness is 7, 8 or 9 gauge. Frequently the center is one gauge heavier than the rim.

2. There should be a sufficient number of teeth for the amount of feed.

   Each tooth should cut as much as is offered to it at a revolution.

   To cut one inch of lumber one may use either:

   Eight teeth, cutting ⅛ inch each at a revolution, or

   Sixteen teeth, cutting 1-16 inch each at a revolution, or

Thirty-two teeth, cutting 1-32 inch each at a revolution.

The number of teeth for one inch of feed should be, in hard timber, 16 teeth; in medium timber, 12 teeth, and in soft timber, 8 teeth.

The usual feed is from 1 to 6 inches per revolution. The quicker the feed the more teeth are required to do the work.

3. The saw must be perpendicularly hung; must slip on the mandrel against the fast collar easily, so as not to twist the saw out of true, thus causing it to buckle when the loose collar is tightened up.

The loose collar is hollow at the center (small saws excepted) and has about 6 inches diameter and ¾ inch rim.

By pressing a layer of writing paper between the collar and the saw the saw may be slightly bent toward or away from the carriage.

4. The saw must be evenly set (either spring or swage set). The teeth, filed square (not to a point but to a cutting edge), must form an exact circle and must retain that form in the course of operation.

5. The teeth must have the proper pitch. A shallow tooth cuts the smoothest lumber, but forbids of rapid feeding.

The modern shape of teeth is such as will facilitate filing and as will preserve the original pitch.

A tooth gets dull over as much of an inch as it cuts.

The gullet of the tooth must be larger for soft wood than for hard wood. Large gullets weaken the saw, small ones increase the friction very badly.

A tooth should be filed two to four times a day. The backs of the teeth must never protrude beyond the point.

Gullets must be kept circular carefully. Any sharp edge in a gullet is sure to cause a crack.

6. The mandrel must not heat in the journals. The boxes require frequent rebabbitting. The stem of the mandrel must be exactly level and perfectly straight.

Mandrels run hot owing to excessive friction in bearings, to excessive tightness of belts, insufficient lubrication or heating of the saw in the center.

A hot mandrel expands the saw in the center, causing crooked sawing.

(e) Lining of the saw with the carriage into the log.

The saw must "lead into the cut" just sufficiently to keep the saw in the cut. The proper lead is ⅛ inch in 20 feet. Too much lead into the cut causes the saw to heat at the rim. A lead out of the cut causes the saw to heat at the center.

The ⅛ inch lead in 20 feet is obtained by sighting over the saw and fixing the saw plane for a radius of 10 feet. This may be done by putting two staffs vertically into the ground 10 feet from the saw center behind and in front of the saw; that done, a horizontal stick is fastened to a head block so as to just touch the forward staff. Then the carriage is gigged backward to the other vertical staff where the horizontal stick must lack exactly ⅛ inch from touching.

(f) Filing room.

Automatic sharpeners and gummers are required for mills having over 15,000 feet daily capacity.

Setting instruments for spring set are similar to those used with cross cut saws, constructed either after the wrench principle or after the block and hammer principle.

The spring set is gradually discarded for the swage set.

In swaging use oil on the point of the tooth, after filing to a sharp point. Swaging should draw the tooth out and should not shove it back.

The set or swage of teeth should increase the gauge at the rim by at least 3-32 of an inch.

The pitch of the tooth might be controlled by a so-called trammel.

Gumming is required to preserve the original hook or rake of the tooth as well as the original roundness of the gullet.

Gumming as well as sharpening are usually done with emery wheels.

Emery wheel rules are as follows:

1. Do not put too much pressure on emery wheel so as not to change the temper of the tooth (bluing and casehardening and consequently crumbling of the tooth).

2. Do not try to fix a tooth fully at one time. Treat it gradually at five or six revolutions of the saw.
3. Proper speed for emery wheels at the rim is 4,500 feet per minute.
4. After gumming remove the irregularities at the edges with a side file, since cracks in saw are apt to start from them.
5. Hammering becomes necessary when the use of emery wheels has caused the saw to expand ("let down") at the rim.

For small mills gumming with a file or a butt gummer is preferable to the use of emery wheel.

Soft wood requires more set or spread and less pitch than hard wood.

Swaging is also called upsetting or spread setting.

(g) Inserted tooth circular saws.

1. The insertion into each socket of the rim consists of a holder and of a chisel point. These points are extremely hard; still they can be filed and swaged with the help of specially constructed files. It does not pay, however, to spend much time in filing since new points are cheap, and since they are readily inserted with the help of a special wrench.

Points are oiled before being inserted.

When renewing one individual point be sure to have it dressed down to correspond to the line of old points.

If the saw guide is not properly adjusted it may touch the holder and smash the saw.

2. Advantages of inserted tooth saw are:

Less experience is required for dressing a saw.

Less filing and gumming.

Less saw repairs in backwoods.

Diameter of saw remains unchanged during its use.

3. Disadvantages of inserted tooth saw are:

The saw kerf is very heavy.

The teeth are large and hence few, so that feed must be comparatively slow.

The price of the inserted tooth saw is higher than that of the solid tooth saw.

The best makes are the Atkins and Disston saws.

(h) The double circular saw.

For big logs and high speed a double circular saw must be used.

The width of the widest board which a single circular saw may cut equals radius minus three inches. Hence much valuable material is wasted in the common circular saw mill sawing heavy logs.

The double circular saw shows an under or lower saw of 56 inches or 60 inches and an upper saw of 30 inches or 36 inches diameter. The top saw should have a reversed motion (so as not to throw sawdust into the lower saw), an arrangement which it is difficult to secure.

A hanger top saw can be added readily to any single saw. Both saws should have the same speed at rim.

The top saw should remain inactive so as not to use up power when small logs are sawn.

Inserted teeth are not used at the double mills.

The advantages of the double saw mill are:

1. Less chattering and truer cut than would be possible for one big saw.
2. Thinner kerf.
3. Faster feed.
4. Less expense for saws.
5. Less repairs.

(i) Remarks relative to "putting up" portable circular saw mills:

The minimum yard required is 50,000 board feet.

The expense of tearing down and putting up again is about $50.

For foundation timbers, place two pieces 8 x 10 inches x 11 feet long on either side of the saw pit (3 feet deep) and underneath the "husk." One piece 4 x 6 inches x 7½ feet long is saddled into the two big pieces, spanning the saw pit underneath the far rail of the track.

Construct the carriage track absolutely straight and level on the track ties (16 to 25 in number) and on the saw pit span.

Place carriage with rack shaft, feed and gig works in place and fasten the track by cleats and nails solidly to the foundation timbers. Then place the husk on them at a distance of about 6 inches from the track, putting wedge blocks between the husk and track. Then spike the husk to its foundation—to begin with in two places only, viz.. at the sawyer's corner and at the middle of the opposite side, so as to enable the sawyer to change the lead by wedging the blocks. Then fix or hang the saw, set the saw guide and fire away.

III. Band saws.

(a) The blade.

The blade material is steel. The width of the blade for log band saws is from 10 inches to 16 inches—14 inches being usual.

Gauge of blade is from 19 gauge to 13 gauge.

Under tension of blade is understood the curvature across the width, which is increased or decreased by hammering at center or at edge. The tension gauge with curved edge guides the filer.

(b) The tooth.

Its width is from 1¼ inch to 2¼ inch.

The hook or pitch is from 40° to 65°.

The depth should be as shallow as possible, with gullets kept round; since cracks usually start from a corner in the gullet.

For sharpening the tooth, a medium soft emery wheel should be used and should not be crowded too hard against the saw, so as to prevent case-hardening.

The teeth are swaged—never spring set—like gang saws. The full amount of set should not exceed 9 gauge in a 14 inch saw.

Side filing or side dressing, after swaging, is usually practiced, although objected to by the saw makers.

For gumming, either a gumming press or the emery wheel is used.

(c) The filing room.

Every band saw mill has a separate filing room equipped with automatic dressing machines, i. e., automatic sharpener, automatic swage, automatic swage shaper, saw stretcher etc.

In the band saw mill, the filer is considered more important than the sawyer for the success of the mill.

Saws are changed three or four times a day.

"Brazing" of a band saw means joining the loose ends, uniformly beveled or ground to a feather edge ¾ inch long. A strip of silver solder is placed between the cleaned laps, which are then taken between the cheeks of the brazing clamps heated to a bright red heat. After pressing the clamps together for several minutes and allowing them to cool, the braze is dressed down with a file to the proper thickness.

The filer arrests cracks by punching a small pin hole or dot at extremity of crack.

(d) The wheels.

The band saw runs, belt like, over two wheels weighing from 1,500 to 3,000 pounds (the lower heavier than the upper) ; the lower wheel driving the upper by the band saw.

The strain on the saw, which should not exceed 5,000 pounds and by which slipping off is prevented, is obtained by raising the upper wheel.

The diameters of the wheels are 8 to 10 feet, the face about 11 inches, the teeth overlapping the wheel.

The crown of the tire is up to 1-64 inch.

The entire length of the log band saw varies from 30 feet to 70 feet.

The saw guides, lined with wood or babbit metal, prevent the cutting part of the blade from bending toward the carriage or toward the wheels, while the guard rolls, standing about 2 inches back of the saw, prevent it from slipping backward at the approach of the log.

The maximum diameter of logs that can be handled by band saws is about 90 inches.

The weight of a band saw mill complete is 20,000 to 40,000 pounds.

(e) The "Allis" double cutting telescopic band saw.

The saw blade has teeth on both edges, so that a board is obtained at each trip of the carriage.

The entire mill is raised or lowered by hydraulic pressure with a view to bringing the top of the logs immediately underneath the upper wheel.

IV. Conclusions.

(a) The superiority of the band over the circular saw lies in a saving of 1,000 board feet in every 16,000 feet of 4/4 inch boards obtained. In heavier planks the saving is less, in lighter boards more. The boards obtained have a better width. Logs over four feet through cannot be handled by circular saws. Further, the band saw allows of a more rapid feed. Hence it is used preëminently for valuable logs, for big logs and for high output.

Frequently mills of large output employ simultaneously band, circular and gang saws, allotting the logs according to their quality, the best to

the band saw and the poorest to the gang saw.
Two edgers and one trimmer can take care of such a combined output.

(b) Mammoth mills are now considered uneconomical, since it is difficult to take care of the output of boards at the outlet from the mill floor.
The output per mill hand in big concerns is up to 7,500 board feet daily.
Four acres of mill pond hold up to 1,000,000 board feet.
Two standard gauge trains supply an output of 100,000 board feet from an average distance of 10 miles, daily.

B. The carriage.

I. The composing parts are:

The truck with head blocks, knees, dogs, set works, and the driving machinery.

The carriage is subject to the roughest treatment. Still, its proper alignment is as essential as that of the saw.

(a) The truck is made of timber at least 6 inches square, thoroughly seasoned and strongly braced and bolted.

Construction material is:
Up North—Norway pine, birch and maple.
Down South—Yellow pine and white oak.

The length should correspond with the maximum size of logs.

So called screw block trailers may be added, increasing the length (in longleaf pine mills) up to 72 feet.

(b) The head blocks, iron with steel face, are let into the timbers of the truck and form a groove for the tongue of the knee, which slides on the head blocks, being moved forward and backward by the set works.

The head block and knee form a right angle into which the log is firmly pressed.

(c) The knee is either solid or hollow and carries the dogs.

The dogs are hooks or clamps or teeth, meant to grasp the log. They are fastened either inside or outside of the knee.

Two tooth bars, playing inside the hollow knee and pressed by a powerful lever, replace the original dogs in modern mills.

"Underdogs" are used in quarter sawing.

The number of head blocks, knees and dogs is variable. The minimum is two of each.

(d) The set works consist of:

The set beam, a shaft running underneath the carriage from head block to head block, with a pinion at each head block. This pinion corresponds with a rack forming the tongue or basis of each knee.

The index disc and ratchet.

The set lever, handled either by the sawyer, in small saw mills, or by the setter, in larger mills.

The set works are usually double acting, so that the knees advance with the to and fro motion of the set lever.

In addition, each knee can be moved individually on its rack by the so-called taper movement.

The knees, before a new log is loaded, are receded either by a spring device or, on the gig motion of the carriage, by a friction device.

The brake wheel on the setshaft acts as a buffer when logs are loaded on the car.

(e) The wheels.

The wheels are attached either to the carriage or to the floor. The near wheels are flat on the tire and the far wheels, called guide wheels, are grooved on the tire.

In band saws, an automatic off-set is required to prevent the face of the log from striking the saw on the gig motion.

The steel rails are invariably placed on stringers.

II. Driving machinery.

The to and fro trips of the carriage are known as feeding and gigging.

In small mills the motive power is derived from the saw arbor by:

(a) Rack and pinion device.

(b) Chain, rope or cable running over one or several sheave drums.

The speed is regulated either by so-called cone pulleys (two, three or four on the same shaft) or by a paper friction device.

The so-called Reamy Disc Friction allows of freely varying the speed.

The usual feed, with the cone pulley, is from ¾ inch to 3 inches per revolution of saw.

In large saw mills the piston of a steam cylinder pushes the carriage to and fro (so-called shotgun feed). In that case the carriage usually runs on three rails (center guide rail).

C. Additional parts of high grade saw mills:

I. "The log haul up" (elevator) consists of a flanged foot wheel and an inclined trough, on the bottom of which runs a strong endless chain driven by sprocket wheels. The chain has steps (called welds) at intervals of about 6 feet.

The haul up is driven by a separate engine or from the main shaft by double gear wheels. It consumes a great deal of power.

At the upper end of the haul up, a log flipper "boxes" the logs out of the trough onto the log deck, which is usually inclined toward the carriage.

On the log deck, the logs are freed from dirt and bark by hand.

II. "The nigger," handled by the sawyer, throws the logs on the carriage and turns them by a boxing movement.

III. "The hog" is a steel box within which the edgings and trimmings are cut into small slices by very strong knives rapidly rotating.

IV. "Dust conveyors" convey the output of the hog and the sawdust automatically to the boilers.

D. The edger.

The boards, falling from the log, are conveyed automatically or by hand to the edger.

I. Parts of the edger are:
   - (a) One or several circular saws of 12 inches to 28 inches diameter.
   - (b) Feed works, either power or hand driven, consisting either of a carriage or of feed rolls or of barbed chains by which the boards are fed into the saws.
   - (c) Edger table.

II. Task of the edger is:
   - (a) Removal of defects, knots, bark edge at the side of a board.
   - (b) Splitting boards into pieces of different quality.
   - (c) Rapid sawing to proper width required for special purposes.

III. Kinds of edgers.
   - (a) Hand feed edger, with one or two saws.
   - (b) Power feed edger, usually with a single saw.
   - (c) Gang edger.

IV. Pointers.
   - (a) The distance between the various saws in gang edgers is regulated by overhead levers or by hand wheels.
   - (b) Several boards can be fed at one time.
   - (c) The attendant of the edger must be a lumber in-

spector at the same time, so as to turn out the maximum value of edged product.

(d) The boards are taken to the edger from the live rolls onto which the board drops from the log, either by hand or automatically, by chain conveyors.

(e) The boards are conveyed from the edger to the trimmer by hand.

E. The trimmer.

In large mills, trimming follows edging. In small mills, edging follows trimming.

I. Parts of the trimmer are:

(a) One or several circular saws about 18 inches in diameter. A one saw trimmer is called a "cut-off."

(b) Feed works, viz.: live rolls or carriage or barbed chains running over sprocket wheels.

(c) Table.

II. Task of the trimmer is:

(a) The shortening of boards to standard lengths of 6, 8, 10, 12 and up to 20 feet, allowing 2 inches extra for shrinkage.

(b) The removal of defects at either end, so as to raise a board into a higher grade.

(c) The cutting of straight ends.

III. Pointers.

(a) Where two saws are used, the distance between them is changed by a lever or by a screw wheel, shifting one of the saws, while it is in motion, along the shaft.

(b) Chain power fed trimmers are used in all large mills. The saws are either jump saws, easily pushed from below the table in pairs, or swing saws, hanging above the table and, similarly, pressed down by the attendant in pairs by a touch on hand or foot levers.

F. Yard work. (Sorting and piling.)

I. Sorting.

The board after leaving the trimmer is taken up by a chain or cable conveyor and passes by the lumber inspector, who pencil-marks its quality.

The various qualities are either at once thrown into parallel gutter conveyors, leading to separate chutes, below which a wagon or truck is in waiting, or are transferred to the piles by endless chain conveyors, by hand trucks and wagons. Frequently elevated roads traverse the yard on which and below which such conveyance takes place.

II. Piling.

Strong, high, horizontal ground sills are of the utmost importance. The front sill should be higher than the middle and back sills, except in shed drying.

In some yards the front of the piles is given an overhanging "batter," to protect it from rain, an arrangement feasible only in low piles. The usual pitch of the pile is 1 foot in 10 feet or more.

The tiers of boards are kept apart by three or four well seasoned 'cross pieces called sticks—sawn 1 inch square and placed directly one over the other.

The usual width of the piles is from 6 feet to 10 feet.

The distance between the piles is at least one foot and should be three feet.

In order to prevent end cracks, the sticking should be placed exactly at the ends, slightly projecting over the ends.

Each pile must contain equal lengths, as "overlaps" are sure to get spoiled.

Valuable wide boards are often painted at the ends.

Oak, ash, hickory and elm require at least four months for air drying; lynn, poplar and pine about two and a half months.

Slow drying involves a loss of interest, large yard room, large insurance and slow filling of orders. Still in the case of high grade hardwoods, the use of the dry kiln is disastrous to the lumber.

Thin lumber does not check as badly as thick lumber. Squares check worst of all.

A fermentation and incidentally a discoloration takes place where two fresh sawn surfaces touch one another.

Each pile should have a roof 12 inches high in front and 6 inches high in back, projecting in all four directions over the pile.

Proper curing of lumber is as important as proper sawing of lumber.

III. Dry kiln.

A dry kiln consists of
- shed with gates closing tightly;
- lumber conduit;
- heating apparatus.

The heat is supplied—slowly—
- either by a hot air fan;
- or by a system of steam pipes;
- or by steam admitted into drying room.

The air in the dry kiln must be kept in constant movement, so as to prevent unequal drying of the lumber in the piles.

Lumber can be more evenly dried by steam than by hot air.

Sapwater heated to boiling point expands 600 times. Consequently, wood at 212° F. contains only 1/600 of the water originally found therein.

Before building a mill be sure to consult insurance companies, submitting mill plans.

The insurance company prescribes the distance between the yard, boiler house, engine house, mill and dry kiln. The rate of insurance on a mill is 5% and over.

### § XVIII. WOODWORKING PLANT.

A. Planing (surfacing, dressing or sizing).

The planer consists of cylindrical cutter heads carrying two to four knives and making 3,000 to 5,000 revolutions per minute. It is preferably belted at both sides.

The smaller the diameter of the cylinder with its knives, the smoother is the planing.

The feeding is done either by two to four feed rolls (above) and friction rolls (below) or by a traveling bed. The entire cutting length of the knives should be uniformly used.

The top cutter should do the heavier work in double surfacers.

The knives are usually sharpened automatically.

Lumber is fed into the machine at the rate of 20 feet to 150 feet per minute. Hardwoods more slowly than the soft woods.

The chip breaker is merely a front pressure bar preventing long splinters from being torn off.

Price of single planers is $100 to $400; of double planers $400 to $800.

No machine should have wood in its construction.

B. Flooring.

The flooring machine is a surfacer having an additional outfit of two side cutters revolving on ratchet spindles, cutting tongues and grooves.

The machines weigh 5 tons and more.

The usual flooring made is hard maple.

Planers and flooring machines must be provided with a folding hood connected with an exhaust fan, so as to prevent the shavings from clogging up the machinery or from pressing themselves into the planed surface.

C. Resawing.

Resaws are either circular or band resaws.

The use of a resaw involves a great saving, since it takes a very fine kerf and at the same time relieves the work of the main saw.

The feed is automatic and consists of four rolls.

Circular resaws have as low as 19 gauge at the rim and are frequently built as segment saws.

D. Ripping.

The rip saw is a circular saw running on a bench and allowing, by a gauge arrangement, to cut any desired width of board or strips. It is usually hand fed.

A power fed gang rip saw is merely an edger.

E. Cut off saws.

Cut off saws are either swing saws, jump saws, stationary saws with carriage moved by hand or automatically, or traveling railway cut off saws when the saw is moved horizontally against the timber.

F. Sand papering.

I. Belt sand papering, for carriage spokes, axe handles, buggy poles etc.

II. Disc sand papering, notably for boxes.

III. Spindle sand papering, for small tool handles.

IV. Cylinder drum sand papering.

The object to be sand papered is always fed onto the machine by hand.

G. Scraping.

Under "scraping" is understood the removal of an extremely thin (not over 1/64 inch) layer of tissue from a planed surface. It is meant to replace and to cheapen the process of sand papering, and is not intended to reduce the thickness. The scraper consists of power driven, smooth feed rolls and of one stationary knife, over which the boards are passed. Corky or stringy lumber cannot be scraped.

H. Mitering.

In mitering the stock is run along the so-called "fence" against a circular saw, the plane of which forms a variable angle with the plane of the saw table.

I. Moulding.

Mouldings are either one, two or four sided.

Cutter heads, into which cutters of variable size and form are inserted, secure any variety of patterns of moulding. Moulders are often called "stickers."

J. Miscellaneous.

Under "matching" is understood the cutting of a tongue and groove into the edge of box boards, flooring boards etc. The work is done by a knife and cutter head.

Under "gaining" is understood the ditching across a piece.

Under "plowing" is understood the ditching along a piece.

"Tenoning" is especially required for doors and blind slats—single and double tenons being distinguished.

Door panels go through a "panel raising" machine.

Sash and door "relishing" means the biting or sawing of large teeth into the tenon.

### § XIX. VENEERING PLANT.

Veneers are either sawn or peeled (sliced). The furniture factory and the package trade use veneers, with entirely different ends in view, on a daily increasing scale.

The thickness of sliced veneers ranges down to 1/120 inch; veneers less than 1/40 inch thick, however, are rarely used.

Sawn veneers are 1/20 inch thick or thicker.

A. Veneer saws.

Any saw of a fine gauge is a veneering saw. Largely used are the:

I. Horizontal mill saw;

II. Fine band saw;

III. Circular saw ground to a fine gauge (19 gauge) at rim, strong (5 to 10 gauge) at center; there is only one collar, to which saw is screwed. Veneer saws consisting of sections screwed to a common centerpiece are common.

B. Veneer cutting machines.

Logs are boiled or steamed (in exhaust) for several hours beforehand. Usually, logs 3 to 5 feet long are used, the length of the log almost equaling the length of the knife.

I. The rotary machine peels any log of, say, over 18 inches diameter, notably poplar, lynn, gum and cottonwood, into thin layers by revolving the log slowly against a sharp stationary knife. A clipper cuts the roll into pieces of proper size for strawberry boxes, staves, potato barrels, box boards, furniture backing etc. The core of the log, some 6 inches in diameter, does not allow of peeling.

II. The stationary log cutter consists of a knife set in a sash frame removing at each stroke a thin slice or board.

C. Advantages of veneering.

I. There is little or no loss of timber for kerf and sawdust. Valuable logs (for furniture, cigar boxes) are invariably veneered nowadays. Logs too short for lumber are fit for peeling.

II. Veneers show little shrinkage and little checking. Hence they allow of rapid seasoning. For that purpose, the veneers are frequently passed between heated rollers.

III. The rotary machine yields very large veneers often entirely free from knots which are merely contained in the core left unpeeled.

### § XX. BOX FACTORY.

A. Kinds of boxes.

(a) Planed or unplaned.

(b) Knocked down or set up.

(c) Nailed, lock-cornered or dovetailed.

B. Material.

Wood as light as possible—readily planed, nailed and treated.

The best is white pine; next are spruce, basswood, poplar and, more recently, yellow pine, hemlock, gum, cottonwood. Elm and sycamore are used for special purposes.

C. Machinery.

A well equipped plant contains planers, resaws, rip saws, cut off saws, box board matchers (which tongue and groove composite sides), lock corner machine (or nailing machine or dovetailing machine), sand paper machine and printing machine (drum pattern).

D. Business side.

The skill of the box maker is shown by working up, without waste, the proper proportions of widths and thicknesses. Careful piling of lumber in the yard, separating according to width and thickness, is very essential.

The interdependence between crop prospects and box prices is easily felt by the box makers.

For large boxes the nailed pattern is preferred, being the strongest. Box shook fasteners and box strapping increase the strength.

The lock cornered box is preferred for starch, plug tobacco and small boxes. Lock cornered boxes are required either by the bad qualities of the lumber or by the quality of the stuff packed. Locked corners demand gluing. "Bevel locked" corners and "inclined locked" corners are scarcely used. The dovetailed box does not require gluing. The mechanical process for stamp locked corners (dovetails stamped into thin boards) is not yet perfected.

E. Expense of manufacture.

I. The manufacture of 1,000 feet of lumber into shooks involves a bill of $4 for labor and $1 for wear and tear.

II. One thousand small lock cornered boxes—9x6x3 inches, ¼ inch thick for frame and 3/16 inch for top and bottom—require 700 board feet of lumber worth $8.50 in case of white pine; $5.10 for labor; $2.72 for glue, wear and tear; $2.50 for ten packing crates.

## § XXI. BASKETS.

A. Willow baskets.

They are hand made, mostly from cultivated shoots of Salix viminalis, amygdalina and caspica. Shoots 1 to 2 years old are used, being cut either in fall or in spring. In the first case, the bundles of shoots are kept in water over winter. The shoots are peeled after the rising of the sap by being passed through an iron or wooden fork; then rapidly dried to retain the white color. In this condition the material may be stored away for years. The shoots are bathed in water before weaving to restore flexibility and toughness. The bottom of the basket is made first, and then, frequently with the help of a model, the standards or uprights of the wall are fixed. The manufacture has been introduced into New Jersey and New York.

B. Wooden baskets.

They are used for picking and transportation of bulky farm produces. Sizes ½ bushel to 2 bushels.

I. The hand made basket, from thin strips split and shaved from basket oak and white oak (sapwood).

II. The Briggs stave basket consists of radial ribs cut from 2¾ inch oak planks; cross cut into lengths varying from 12⅝ inch for ½ bushel to 18 inches for 2 bushel baskets. The ribs are jointed and pointed to an exact fit for a round center plate and then bent over a model form having grooves indicating the proper position for each rib and for the strong elm hoop clasped around the rim.

III. The common wood basket is made of straight long ribs up to ¼ inch thick, cut on a rotary veneer machine. No center piece, no pointing and no jointing are required. The ribs are bent over a model form. A workman is said to make about 300 baskets in a day.

## § XXII. COOPERAGE.

A. Terminology.

I. "Slack" cooperage turns out barrels for packing lime, vegetables, cement, salt, nails, crockery, sugar, flour, etc.

II. "Tight" cooperage deals with barrels for liquids and for meat (pork).

B. Material used:

Any species may be used for slack cooperage. Alcoholic liquors must be cased in white oak (Quercus alba, michauxii, prinus, macrocarpa, minor etc.). Red oak will not hold whisky, but is used for other staves, flour barrel heading, sawn and coiled hoops.

White ash is used for pork staves and butter tubs.

Elm yields the best coiled hoops and the best slack staves.

Cottonwood and gum are cut for staves on a large scale.

Chestnut is used for cheap slack barrel hoops; yellow poplar for tobacco hogsheads; basswood for flour barrel headings; beech and maple for sugar barrels; second growth of hickory, birch and ash for hoops.

For buckets, red and white cedar; for tanks, cypress and redwood are preferred.

C. Specifications:

I. Flour barrels contain 196 pounds, or 3.57 bushels, or 32 gallons of flour.

The diameter of the head is 17 inches; the length of the staves 28 inches.

The forms preferred in slack cooperage, either locally or for given goods, vary to such a degree that figures descriptive of the forms cannot be recorded.

II. The "Tight Coopers' Union" specifies:

(a) Whisky barrel staves—length 34 inches to 35 inches, thickness 7/8 inch, width 4¼ inch after jointing, measured across bilge on the outside.

(b) Wine barrel staves—length 34 inches, thickness 11/16 inch after drying and planing, width 4½ inches.

(c) Oil, tierce and pork staves have similar dimensions, allowing, however, of sap, one or two sound worm holes and knots showing on one side only.

Variations of 1/8 inch in length and 1/16 inch in thickness are permitted in all staves (so called equalized staves).

Pipes, butts and puncheons contain over 100 gallons and are used for port, rum etc.

A hogshead of claret is 46 gallons.

D. Statistical notes:

I. One thousand feet board measure in logs—Doyle's rule—yield 2,500 sawed flour staves, 3,200 veneered staves, 4,000 cut hoops or 3,000 sawn hoops.

II. One cord of bolts, with the bark, will make 1,000, or, without bark, 1,200 slack staves.

III. In Tennessee, eight white oaks (of over 18 inches diameter) are said to average 1,000 half barrel beer staves.

E. Prices and their tendency:

| | Apr. 1, 1901. | Feb. 10, 1904. |
|---|---|---|
| Staves— | | |
| No. 1, flour barrel, per 1,000 | $ 9.00 | $11.00 to $13.50 |
| No. 1, cottonwood, per 1,000 | 6.00 | .............. |
| No. 1, gum, per 1,000 | .... | 10.00 to 12.00 |
| Memphis white oak, without sap | 26.00 | 44.00 |
| Heading— | | |
| No. 1, flour barrel, per set | .05½ | .08 to .08½ |
| No. 1, gum, per set | .04 | .07½ to .08 |
| Hoops— | | |
| Coiled elm hoops, per 1,000 | 7.00 | 9.00 to 10.00 |
| Hickory hoops, per 1,000 | 6.00 | 6.25 to 6.75 |
| Barrels— | | |
| Flour, 12 hickory hoop barrel | .41 | .45 to .48½ |
| Flour, 8 patent hoop barrel | .39 | .46 |
| Flour mugwump (10 hickory hoops) | .39 | .45 |
| Oil (52 gallon) | .... | 1.45 |

The price of white oak material has risen rapidly and must continue to rise indefinitely, substitutes for white oak being impossible.

In slack cooperage, on the other hand, raw material continues to be plentiful, and new, cheaper forms of packages enter into daily competition with the barrel.

The cost of making tierces at Chicago is: Staves ($21 per 1,000), 39 cents; heading, 16 cents; hoops, 20 cents; wages, 25 cents; total, $1.

F. Manufacture of heading, staves, hoops and barrels.

I. Heading.

Heading for tight cooperage is sawn from split bolts. These bolts are obtained in the woods by halving, quartering and splitting (by hand and always with the grain) round blocks which slightly exceed in length the diameter of the heading. The heart of the bolt is not removed. The bolts are wagoned or sledded to the heading plant, where they are inspected, sorted, piled and air dried.

Twenty-five horsepower are said to be required at a heading plant. The output at a "setting" of the plant averages 200,000 sets of heading.

The tight heading plant usually contains a sawing machine, an equalizer and jointer.

(a) The heading sawing machine consists of a vertical circular saw (44 inches diameter) screwed to the arbor without a loose collar; a pendulum swing with "grate" and "dogs" to receive the bolt; a slide guiding the swing; a gauge, adjusted by screws; a separator throwing the sawed slats to the side. Price $300.

(b) The equalizer contains a tilting table or a carriage, which is forced against a pair of circular saws.

(c) The jointer edges the slats. It consists of a strong wheel carrying on its side 4 to 6 straight knives. The wheel is covered by a hood. Price $140.

For tight cooperage the joints are made secure by blind wooden nails and by coopers' flag (Typha latifolia) glued into the joints.

Two more machines are required to finish the heading prepared by the apparatus mentioned under a, b. and c, viz.:

(d) The heading planer carries knives 16 inches to 24 inches wide and has a capacity of 8,500 headings a day.

(e) The heading turner cuts the heading circularly and carves the required bevel edge. It usually carries a concave saw, to cut through the boards, and on the same mandrel a small, thick circular saw which gives the bevel.

The heading, held in clamps, rotates obliquely against these saws. Price $235. Capacity 5,000 a day. Heading is usually kiln dried.

For slack heading, quarter sawing is usually not required. Ordinary lumber can be used. The slack heading plant may or may not contain all of the machines enumerated under a, b, c, d and e.

The tight heading plant of the woods contains the machines a, b and c, while the machines d and e are usually combined with the cooper works, unless they form a separate establishment.

II. Staves.

(a) Staves for barrels containing the more valuable beverages are hand made (rived staves). The riving of staves wastes timber. Proper bilge and curvature are obtained either by hewing (Germany) or in the finishing plant (America).

The white oak timber used must come from straight trees of over 18 inches diameter. Such trees are found in clumps only. Hence the necessity of a portable finishing plant, using from 15 to 35 horsepower. At each set or site—now usually 15 miles from the railroad—at least 100,000 staves are manufactured. Six hundred rough staves have the weight of 1,000 finished staves. Hence it is wise to bring the plant close to the timber.

The felled tree is sawed (by hand) into blocks of two inches more than stave length, which are placed on their larger ends. Then the sap line is demarked with a pencil, and inside the sap line, with the help of a pattern showing the cross section of a stave, as many staves are pencil-marked as possible.

By axe, wedges and wooden mauls the block is then halved and quartered (and rehalved and requartered in case of heavy blocks), the clefts following the pencil marks. The sectors are then split, along the annual rings, into rough staves—always following the pencil marks.

The core of at least four inches diameter, containing the small limb-stubs, is thrown away.

The rough staves are inspected and sorted and piled hogpen-fashion for air drying, either before or after sledding or wagoning to the finishing plant. It might be added here that this finishing plant is—contrary to expectation—never combined with a heading plant.

(b) The "stave bucker," by which three-fourths of all rived staves made in the United States are refined, dresses and planes both sides of the staves to proper curvature and bilge. A rack forces the rough staves through the narrow passage left between two knives (either straight knives, or curved to correspond with the periphery of the finished barrel) which are fastened in a rocking frame.

(c) The "stave dresser" frequently takes the place of the bucker. It carries knives on two cutterheads, dressing and hollowing the stave on both sides to proper thickness and leaving either an abrupt or a gradual shoulder

(d) The stave saw yields staves of equal form, but greater permeability, more economically than the hand. Stave bolts must have the following minimum dimensions: thickness with grain 5 inches; width close to heart 3 inches.

The bolts are barked and hearted in the woods, being split from logs having at least a diameter of 15 inches inside the bark.

The stave saw consists of:

1. A hollow steel cylinder, having the diameter of the barrels to be made and carrying saw teeth at one end.
2. A carriage with clamps passing the saw cylinder.
3. A stave holder running into the cylinder and removing the sawed staves. Capacity 12,000 staves per day.

(e) In slack cooperage, a stave cutter is often used, consisting of a circle (20 inches for fruit barrels) with one knife attached, making 150 revolutions per minute. The stave bolts are steamed beforehand. The knife separates at each revolution of the circle, or by each single stroke, a stave from the bolt.

Capacity 140,000 per day. Price $130. Horsepower, 4.

(f) The rotary veneer machine is now also used to cut 4 inch or 4½ inch gum staves.

(g) The stave equalizer trims the ends and gives the staves the proper length. It consists of two circular saws and a tilting bed or a carriage.

(h) Stave listers or jointers edge the staves in such a way that the edges coincide with a plane through the axis of the barrel.

Staves for export are straight listed and without bilge.

The stave jointer is either a circular swing saw or it consists of two circular saws; or of a number of inclined knives held by cutterheads; or of one knife running in a sash frame; or it resembles a heading jointer (starjointer).

(i) In the "stave planer," a steel pattern passing through the machine with the stave lifts the cutters in such a way as to allow the shoulders of the staves to retain a greater thickness than the middle of the staves.

III. Hoops.

In tight cooperage, steel or iron hoops are used, driven over the barrel by hoop drivers or trussing machines and sometimes fastened by hoop fasteners.

In slack cooperage, wooden hoops are still preferred and wire hoops are only occasionally used. Wooden hoops are either hand made, especially the long white oak hoops used on tobacco hogsheads, or sawed from plank by a hoop machine, or finally knife-cut on a rotary machine or a sash frame machine.

A machine by which sawed hoops are obtained directly from logs does not seem to be much used. By special machinery hoops are planed, pointed, lapped and punched.

A hoop coiler rolls the hoops into bundles; usually the outfit of a "sawed hoop" plant consists of a saw bench, a saw machine and a coiler.

IV. Barrels.

Putting up a barrel requires:

(a) Heating, in order to increase the flexibility of the staves held together by an iron form and by one or two hoops.

(b) Bending in an apparatus consisting of screw and rope, windlass and rope, or of a funnel press.

(c) Crozing, i. e., making a groove for the insertion of the heading, either by a hand planer or by a power groover.

The finished barrel is automatically planed on the outside; if it does not assume the exact form of a doubly truncated parabolloid, it is pressed into shape by a barrel leveler.

§ XXIII. WAGON WORKS.

A. The raw material must be tough and strong and, above all, air dry. The dry kiln often follows after two or three years of air drying.

Second growth of black or shell bark hickory is used for tongues, shafts, spokes, rims, axles, neck yokes, whiffletrees and eveners.

White oak or burr oak is used for spokes, tongues, bolsters, hounds, reaches and axles.

Black birch, rock elm, white oak and locust are used for hubs.

Wagon beds are made of yellow poplar, pines, cottonwoods, the composing boards being either ship lapped or tongued and grooved.

White ash, bending easiest and best of all woods, is used for rims, bent seats, bent bows, shafts etc.

B. The manufacturing machinery is usually supplied by the Defiance Machine Works, Defiance, Ohio.

I. Hubs are cut direct from log to proper length by double equalizing saws and are turned on outside automatically on a lathe; bored for boxes (thimbles); chisel mortised for spokes; and set with two to four iron rings.

II. Spokes are obtained from bolts by rip sawing into squares which are turned on a lathe; tenoned at the big end; equalized in length; sandpapered and polished; and driven into hubs by automatic hammers.

III. Rims and felloes are either bent to proper form or sawn from straight bolts. In the first case, the bolts are steamed or boiled; then bent and pressed in an iron pattern when hot; then cased up and dried; then bored to receive the spokes; rounded on the inside with a slight elevation left around the hole; planed and finally sandpaper polished.

Very wide plank is required for sawn felloes, which are obtained either by a set of concave saws, having the required curvature, or by a narrow band or scroll saw which follows the pencil marks of a pattern made for each piece on the plank.

IV. Axles are turned on a lathe according to a steel pattern spanned in the lathe; are gained to receive bolsters and hounds; and have the thimble skeins driven on by hydraulic pressure.

V. Shafts and poles are sawn from plank 1½ inch to 2½ inch thick and 8½ to 12 feet long; are heated and bent, cased, dried, rounded and belt polished.

C. Few establishments make entire wagons. Usually shafts, spokes, rims, axles etc. are made in factories close to the woods, while other factories closer to the cities or to railroad centers put the wagons together after buying their component parts.

## § XXIV. SHINGLE MILLS.

A. Material.

Breasted, shaved, rived or rifted shingles (meaning hand made) are used in the backwoods only. At Biltmore, shaved shingles made of chestnut cost $2 per M., while so called boards, two feet long and six inches wide, split from white oak, cost $3 per M.

Shaved shingles cannot be laid so neatly as sawn shingles.

For machine made shingles are used:

On the Pacific coast, red cedar;

In the Lake States, white pine, white cedar, spruce, norway pine and hemlock;

In the South, cypress, longleaf pine and shortleaf pine.

B. Durability.

The durability is said to be for:

White pine rived, 20 to 35 years.
White pine sawn, 16 to 22 years.
White pine (sappy) sawn, 4 to 17 years.
Chestnut rived, 20 to 25 years.
Cedar sawn, 12 to 18 years.
Spruce sawn, 7 to 11 years.

C. Specifications.

The usual size of sawn shingles is: 16 inches or 18 inches long; 4 inches wide; 1-16 inch thick at small end; ½ inch thick at butt end. A bundle of shingles contains 250 pieces, is 20 inches long and has 24 tiers.

A carload of white pine shingles, weighing 22,000 pounds, contains 70,000 16-inch shingles; a large car of red cedar shingles contains 170,000 pieces.

One thousand shingles cover 100 square feet of roof, each showing 14.4 square inches to the weather.

A rule for the number of shingles required for a roof is: ascertain number of square inches in one side of roof; cut off the last figure, and the result is the number of shingles required for both sides of the roof. In this case, each shingle shows 20 square inches to the weather.

Shingles are usually laid to show 4 inches of their length, which arrangement yields, in 16-inch shingles, a quadruple layer of shingles on the roof. The higher the grade of the shingles, the larger is the weather face permissible.

D. Machinery.

The machinery used in a shingle plant consists of:

I. Drag saw, either driven from a countershaft or acting directly from the piston, cutting the logs into shingle lengths.

II. Bolter, a circular saw cutting the round blocks into bolts, the thickness of which equals the width of the shingle. Bolts split with an axe yield a better grade of shingles but cause a large waste of timber. A knot saw may be used after bolting to remove knots, rot, sap etc.

III. Shingle machine, constructed in a variety of forms:

(a) A knife is spanned in a sash frame moving up and down and severing a shingle at each stroke from steamed bolts. This system, furnishing "cut shingles," is not much used.

(b) The shingle saw machine uses a circular saw lacking the loose collar and screwed onto the fast collar. The gauge at the center of the saw may be very heavy while the gauge at the rim is from 15 to 20 only.

The shingle blocks are fastened into either a sliding frame or a rotating frame and are tilted continuously, so as to alternate edge and butt cuts. The sliding frame is either hand fed or power fed. A machine takes from one to ten blocks at a time.

IV. The jointer is meant to give a rectangular shape to the shingle. It is either a single or a double rip saw (two saws 4 inches apart) or a wheel jointer consisting of a steel wheel carrying, close to the circumference, 4 to 8 knives radially or almost radially set and of a hood covering the machine and connected with a blowpipe to remove shavings. The shingles are placed opposite an opening in the hood and pressed by hand against the knives, which make about 500 to 800 revolutions per minute.

V. The shingle packer, used for 16 inch and 18 inch shingles, consists of a bench and two slotted and overhanging steel rods. The attendant pressing the rods down by hand or foot packs the shingles tightly with their fine ends overlapping.

VI. Shingle planers, fancy butt shapers and dry kilns are found in up to date plants. After dry kilning, bundles require tightening up.

## § XXV. LATH MILL.

The usual length of laths is 4 feet; the weight per 1,000 is 500 pounds. One thousand laths cover 70 square yards, and a cord of slabs yields 3,000 laths.

All softwoods, further yellow poplar, cottonwood and linden form the raw material for lath.

The machinery used consists of:

A. Slab resaw, by which the last board is cut out of the slab. It contains a circular saw and feed works pressing the slab in to the saw.

B. Lath bolter, consisting of a single or double cutoff.

C. Lath machine, which is either an ordinary rip saw having up to six small circular saws and an automatic feed, or a cutter-head and knife machine. The latter machine makes the so called "grooved" lath.

D. Lath bundling machine, which presses the laths together by a foot or hand lever and facilitates binding.

## § XXVI. CLAPBOARD MILL.

The cross section of clapboards is either square or, more usually, beveled, with the big edge from 3/8 inch to 5/8 inch thick.

They are manufactured either from boards 1 inch thick fed through a resaw, the feed rolls of which are inclined toward the saw, or by special clapboard machinery directly from the log. Logs, in the latter case, are cut in pieces of proper lengths (4 feet to 6 feet) by a drag saw;

are turned on a lathe and then spanned into a sliding frame (between pins). Frame and log pass a circular saw with and not against the rotation of the saw. After passing, the log is automatically turned by an angle corresponding with the bevel of the clapboard.

This process leaves a four inch core unused.

A planer, molder or jointer dresses the sides and a butter or trimmer dresses the ends.

### § XXVII. NOVELTY MILL.

Novelty mills have sprung up, in recent years, all over the Northeast, manufacturing trays, wooden dishes, wooden wire, rules, pen-holders, flasks, skewers, toys and thousands of playthings of the hour.

The variety of the raw material used is as great as the variety of the goods manufactured. Still, birch seems to be the acknowledged leader for novelty makes.

Wooden dishes and wooden wire may deserve particular mention.

A. Wooden dishes.

I. Material.

Yellow poplar is used for large wooden trays. Second growth white pine (cuts taken between whirls) is said to be used in New England. Maple is preferred for small oval wood dishes, turned out by a special machine automatically.

II. Manufacture of oval dishes.

These oval dishes are obtained from sawn blocks, scaling from 6 inches by 8 inches to 7¼ inches by 9½ inches.

The dishes are cut with the grain from the side face. Blocks are thoroughly boiled. The cutting knife, revolving circularly, makes 25 dishes to the inch and 75,000 per day.

Two facing knives shave the block clean between every two cuts, carving out true edges.

A screw fed carriage automatically feeds the block into the knives. No skilled labor is required. The attendant merely removes the remnants of a spanned block and places a new block in the carriage.

B. Wooden wire.

Wooden wire is used for mattings, screens, inner rack of ladies' hats etc.

The raw material consists of willow, basswood and poplar plank.

A series of planing knives, in the form of sharp rimmed, fine steel cylinders, plies in a sliding frame over the plank, severing at each stroke a series of wires having the length of the plank.

A straight planer knife follows in the wake of the fine cylinders, removing the irregularities left on the plank.

§ XXVIII. MATCHES AND THEIR MANUFACTURE.

Wooden matches are either round or square.

A. Round matches are made on a machine resembling the wooden wire machine described in Section XXVII.

B. Square matches are made from blocks 16 inches to 24 inches long which, after steaming or boiling, are peeled on a rotary veneer machine into layers having the thickness of a match.

I. The veneers are automatically clipped into sheets having a length of 6 feet and width equaling 5 to 12 match lengths. These sheets are heaped up in packs containing 50 to 60 tiers.

II. A knife system, with vertical spur-knives, plays in a vertical sash and cuts from each tier, at each stroke, 5 to 12 matches. The pack, after each stroke, is moved forward the thickness of a match. The machine has a daily capacity of 25,000,000 matches.

III. The matches are then dried and cleaned by sifting.

C. The treatment thereafter is identical for round and square matches, consisting of the following operations:

I. Causing the match pegs to lie parallel, by rocking them in an oscillating drawer.

II. Fixing about 2,250 matches at a time in a clasp or frame.

III. Dipping the clasp (for fine matches) wholly into paraffine and the tips thereafter into a chemical compound (mastic) which forms the inflammable head. The mastic consists of one or more oxidizing substances (chlorate or bichromate of potash), often mixed with a particle of some explosive, so as to allow of ignition by friction on any rough surface.

D. The raw material for matches is derived from cottonwoods, linden, sapwood of yellow poplar, white pine, spruce. A white, soft and long fibre is required.

§ XXIX. SHOE PEGS AND THEIR MANUFACTURE.

A. Wooden shoe pegs are used to fix the "uppers" to the shoe sole and to construct the heel. The pegs are automatically fed from a pegging machine.

Pegs are 3/8 inch to 7/8 inch long, square with a prismatic head.

The raw material consists of birch and hard maple.

B. Manufacture.

I. The blocks are cut into discs, 3/8 to 7/8 inch thick, by a circular saw.

II. The discs are pointed in a pointing machine, which plows parallel grooves, lengthwise and crosswise, into the discs. The distance between two furrows equals the width of the peg.

III. The splitting machine severs, by the gradual strokes of a knife (first stroke down to ½, second stroke down to ¾ of thickness of disc), the disc into strips of pegs and, playing crosswise, into individual pegs. After each stroke of the knife the disc is moved toward it by the width of one furrow. During the operation the disc is held in a leather frame.

IV. The wet, red pegs are then bleached by applying sulphuric acid; then dried in heated drums; then cleaned from splinters and irregularities by sifting.

### § XXX. EXCELSIOR MILL.

A. Grades of product.

*First Grade*—Fine wood wool, thickness from 1/500 inch to 1/64 inch.

*Second Grade*—Common fine wood wool.

*Third Grade*—Mattress stock.

The greatest demand is for stock 1/100 inch thick and from 1/32 to 1/8 inch wide.

B. Usage. Excelsior is used for upholstering and for packing (glassware, furniture, confectionery etc.). It is preferred to straw owing to its greater elasticity and to its lack of dust. It is easily colored. A limited amount of excelsior is woven into mattings and rugs.

C. Kinds of wood.

Basswood is best; balm of gilead, cottonwood and yellow poplar come next. Pine and spruce also are used. One cord of wood will yield 1,500 pounds of excelsior.

D. Process of preparation.

The wood is peeled, cut into 38-inch blocks, and the blocks split into slabs 5 inches to 6 inches thick. These slabs are thoroughly air seasoned under cover, and finally cut into two lengths of 18 inches each.

Frequently the core of blocks peeled on the rotary veneer machine is used for excelsior.

E. Machinery.

Excelsior machines are small, upright knife machines, or carry the knives on a disc set in rapid rotation. The modern machine, however, is an eight block horizontal machine consisting of:

I. Two sliding steel frames carrying eight tool heads into which the knives and the comb-like spurs are spanned. The sliding frames are moved by powerful cranks and pitmans on maple slides.

II. Two stationary frames, above the sliding frames, each having four sets of rolls, each set pressing a block by its rotation downward against the knives.

III. The shavings, falling through the sliding frame, are carried out by broad belts.

IV. The daily capacity of an eight block machine is 4,000 pounds of fine wood wool, or 10,000 pounds of mattress stock.

V. Additional machinery consists of automatic knife grinders, baling presses, cut off saws etc.

VI. The price of the machinery for a modern plant is about $2,000. About 30 horsepower are required.

## § XXXI. GROUND WOOD PULP AND CHEMICAL FIBRE AND THEIR MANUFACTURE.

A. Historical remarks.

Up to 1854 paper was made from cotton, linen and hemp fibre, precipitated from a mush in the shape of a matting.

Wood grinding was invented in 1854. Since 1867 the ground wood is refined by chemical processes which separate the wood into thinner strings of cells and free it from rosin, tannin, albumen, gums etc.

In the United States there were, in 1890, 82 mills producing $4,600,000 worth of wood paper, while the value of the output in 1900 approximated $20,000,000.

Rags, manila, straw and waste paper used as raw material for paper still outrank in value (in 1900) the wood used as raw material.

In 1900, close to 2,000,000 cords of wood were consumed, worth nearly $10,000,000; three-fourths being spruce and one-fourth poplar and miscellaneous.

If the United States shall conquer the Swedish and German export and supply the entire consumption of wood paper at home, 6,000,000 acres of well managed wood lands will be required to produce the raw material.

B. Statistical remarks.

One cord of wood yields one ton of ground pulp wood (mechanical fibre) or ½ ton of chemical fibre. In the so called "news grade" 80% of pulp is mixed with 20% of chemical fibre.

Japanese paper is made of the inner bark of a mulberry tree (Brussonetia).

For highest grades of writing paper, cotton and linen are used.

An average mill produces 25 tons a day.

A modern pulp plant requires annually, at least, 6,000 cords of wood; a modern fibre plant at least 25,000 cords.

The price of the product loco factory is about:

For ground wood pulp, $13 per cord;

For soda fibre, $20 per cord;

For sulphite fibre, $25 per cord.

C. The plant.

The plant requires an outlay of about $10,000 per ton of daily production. Unlike a saw mill, a paper mill cannot be shifted when the nearby supply of raw material is exhausted.

A plant must be located:

I. Close to water; water is not so much used for motive power as for the dissolution of the fibre in the washing process.

II. Close to cheap wood supply; wood must be plentiful and uniform, of a long, straight fibre, readily interlacing and white. Spruce is considered best, the price at river fronts being about $3.50 per cord and at mill from $4.50 to $5.50. Cottonwoods and poplar are next in importance. Price at river fronts $2. Hemlock and balsam are mixed with spruce in a daily growing proportion. Birch, beech and maple can be used only for wrapping paper and cardboard, the fibre being short, brittle and unbleachable.

The use of pine is handicapped by the expense of the removal of the rosin.

The Pacific spruces and cottonwoods may have a great future.

III. Close to cheap coal, since the coal consumption per pound of paper amounts to 5/16 of a pound of coal. So much coal is required for heating, drying and bleaching, that all excepting 15% of the machinery can be driven free of charge.

D. Process of manufacture.

The manufacture is either purely mechanical (ground wood pulp) or also chemical. In the latter case, distinguish between the soda process, the sulphite process and the sulphate process. The electric process, though very promising, is still in early infancy.

The principle of manufacture is:

Grinding and beating of wood in water until it forms a fluid pulp; allowing water to run off leaving a matted stratum of wet fibre; bleaching; drying; pressing.

I. Ground wood fibre.

(a) The wood is cut into bolts one foot long and five inches thick. The bark is removed, and the knots are usually bored out.

(b) The bolts are pressed against stone mill-wheels which turn slowly under constant influx of water. Bolts must be ground in the direction of the fibre.

(c) The fluid pulp is carried through sieves retaining the long splinters, which are transferred to a pulp engine for mechanical refining.

(d) The fibre is ground a second time both in stampers and rotary mills.

(e) The fluid is separated according to fineness by sieves of different mesh which allow the water to run off. The filtered mass is taken up by endless belts of cloth which carry it as a thin matting through a series of heated rolls.

(f) The mattings are dried by superheated steam, by pressure or in the air. Pulp is shipped in rolls about 3 feet long and 1½ feet in diameter. It is not paper but merely the leading raw material for ordinary paper.

II. Soda process.

This process consists of:

(a) Sawing wood into discs about 1 inch thick.
(b) Grinding and dissecting the discs into fragments about 1/24 inch by 1 inch in size.
(c) Packing the material into perforated iron boxes which are placed in digestors containing a solution of caustic soda.
(d) Boiling the wood for four hours under a pressure of 125 pounds.
(e) Grinding between stones.
(f) Repeated washing and sifting.
(g) Bleaching with chlorate of lime and washing.
(h) Taking up mass by endless rolls of cloth and drying it between heated rollers.
(i) Reclaiming caustic soda by boiling and melting.

III. Sulphite process.

Same as the soda process, excepting points "c," "d" and "g."

The wood fibre is first cooked without chemicals and then boiled for 60 hours with calcium sulphite—a cheap chemical usually prepared at the mill itself.

No or only little bleaching is required, the fibre being free from color when leaving the digestor.

The expense of manufacture per ton of sulphite fibre is said to be as follows:

| | |
|---|---|
| Two tons of spruce | $ 9.00 |
| Coal | 3.00 |
| Sulphur | 3.30 |
| Lime | .70 |
| Labor inclusive of office force | 7.00 |
| Wear and tear | 2.50 |
| Total | $25.50 |

These figures may seem to be unusually high.

The sulphite process offers the following advantages:

(a) It is cheaper (no bleaching, cheap chemicals).
(b) It does not interfere with the strength of the fibre.
(c) It yields a larger output of fibre per cord.

Hence the sulphite process is rapidly superseding the soda process. Exception in poplar.

IV. Sulphate process.

It is adopted in mills originally arranged for caustic soda process. The chemical used is sodium sulphate, the price of which is only one-third that of caustic soda. It is reclaimed out of its watery solution by evaporating and melting. This process gives the old soda mills a new lease of life which were about to be forced to the wall by the superiority of the sulphite process.

V. Electric process.

The electric current is used to obtain from an 8% solution of common salt (Na Cl) its composing parts, viz., caustic soda and hydrochloric acid.

These substances, alternatingly acting upon the wood prepared in the manner described under II, a, b, and c, dissolve the lignin and destroy the incrustations of the fibre, so that pure cellulose remains in the digestors.

Two digestors are used, connected with the positive and the negative electrode of the current respectively.

The process is said to be faster and cheaper than the sulphite process. No bleaching required.

## § XXXII. TANNING MATERIALS AND TANNERIES.

A. Tanning materials.

Tanning materials used in the United States were in 1900:

Hemlock bark, 1,170,000 cords.
Oak, 445,000 cords.
Gambier, 128,000 bales.
Hemlock bark extract, 13,000 barrels.
Oak bark extract, 54,000 barrels.
Quebracho bark extract, 20,000 barrels.
Sumac bark extract, 8,500 barrels.
Chemicals, $2,225,000 worth.

In the sole leather, belt leather and harness leather industries, vegetable tanning material is still preferred. Mineral or chemical tannage, however, has been developed during the last ten years to a degree threatening to entirely supplant the old methods.

Since 1900, extracts obtained from chestnut wood have gained both favor and importance.

B. Tanbark in particular.

I. Notes on tanbark.

(a) The corky layers of bark do not contain any tannin and are usually shaved off. In Europe, young oak bark not having any cork is preferably used.

(b) Fresh bark contains on an average 45% water and shrinks heavily during the drying process.

(c) While oak bark must be peeled in spring immediately when the sap begins to rise (April-May), hemlock bark may be peeled at any time from May to September.

(d) Bark peeling season for oak is from early April to the end of June. Trees in the bottoms peel earlier than those higher up.

The bark on the uphill side of a tree is thinner than the bark on the downhill side.

Trees exposed to the weather, isolated, on unprotected slopes, have short boles but a heavier bark than those growing under the reverse conditions.

Dying trees will not peel.

II. Peeling process.

(a) Girdle the tree about four feet above the ground; remove bark from stump and roots; fell the tree in such a way as to leave the bole well raised above the ground.

(b) Notch (with axe) a line along the tree and rings around the tree every four feet. Have two men with "spuds" peel the ringed sections, and see that the pieces peeled are as wide as possible and, as near as possible, four feet long. Large pieces will dry well and will save expense in handling. Handling costs more than peeling.

(c) Lean the peeled pieces against the felled bole, preferably flesh side out, as high above ground as possible, and see that the air circulates freely around them.

(d) See that the bark is as little shaded as possible. Peel before leaves are out. Never leave bark to dry in a moist gully.

(e) Toward evening, turn the flesh side of the bark toward the object supporting it so as to protect it from dew. The expense of "curing" is so high, however, and the danger of spoliation by rain so great, that bark is now usually placed at once "bark side out."

(f) Pile the bark after two to three days, provided it is not wetted, close to the tree in loose piles. These piles are left for weeks in the woods. Bark is sure to mold if a rainy season sets in. Free access of air greatly reduces the danger of damage.

(g) Finally sled the bark, by hand sleds, cattle or mules, over rough trails (best grade is about 20%) to the wagon roads, to be removed to tannery or railroad.

III. Remarks.

(a) The minimum diameter of trees and branches peeled depends on the price of bark and the price of stumpage. At the present time, far from the tannery, it does not pay to peel pieces of less than 10 inches diameter.

(b) The expense of the harvest of oak bark is per cord:

Roads, 45c; felling, 27c; peeling, 57c; piling, 72c.

On the average a man will peel per hour from 0.3 to 0.38 cord.

(c) Tannin percentages of dressed bark are, after Sargent:

| | | | |
|---|---|---|---|
| Mangrove | 30 % | Burr and red oak | 4.6% |
| Sumac | 18 % | Chestnut | 6.7% |
| Sassafras root | 58 % | Douglas fir | 13.8% |
| German oak | 14 % | Eastern hemlock | 13.1% |
| Cal. Chest. oak | 16.5% | Western hemlock | 15.1% |
| Live oak | 10.5% | Eastern spruce | 7.2% |
| Chestnut oak | 6.2% | German spruce | 8 % |
| Spanish oak | 8.6% | German fir | 6 % |
| Black oak | 5.9% | Larch | 7 % |
| White oak | 6 % | Birch | 4 % |

C. Wood extracts in particular.

I. Tannin extracts are manufactured from bark, chestnut wood, quebracho, mangrove and oak. Quebracho wood contains 24% of tannin; chestnut wood 14% (?) of tannin.

II. The wood is shredded in a chipper and the tannin extracted (not entirely) by steam or hot water under pressure. The liquid obtained is condensed.

III. While in France the sappy branches and young shoots of chestnut are preferred, in America the heart wood and especially the butt is preferred.

IV. The wood is cut 4 feet to 5 feet long. The leather trust uses a cord of 160 cubic feet = 1¼ cords of 128 cubic feet.

V. Clear water, cheap transportation and cheap fuel are required for successful manufacture.

Only sound wood is used; wormholes in chestnut, however, do not interfere with its value.

VI. Extracts exposed to air or exposed to heat spoil rapidly.

VII. Extracts are shipped in barrels of 56 gallons capacity or in tank cars.

VIII. The price of chestnut extract is 1½c to 2c per pound. At a price of 1½c, extract is cheaper than oak bark at $6 per cord.

IX. One cord of chestnut wood yields 500 pounds of extract containing about 25% tannin.

D. The methods of tannage employed nowadays are:

I. Tanning by means of aluminum salts.

II. Chamoying by means of certain oils or acids of oils.

III. Tanning by salts of chromium.

IV. Vegetable tanning, using the wood of quebracho, chestnut and oak; the bark of various oaks, hemlock, spruce, douglas fir, birch, larch, willows; fruits, cups and galls, i. e., divi-divi, catechu, myrobalans; further, the leaves of sumac. Instead of using these vegetable matters, their watery extracts frequently are applied.

E. Object of tanning.

Tannage tends to render the skin permanently supple and durable by impregnation with tannin. Aside of the mechanical imbedding of molecules by impregnation, a chemical action (fermentation) may take place in the case of bark tannage, due to the presence of microbes in the bark, chemically binding the tannin to the albumen and gelatine of the skin.

F. Criteria of a good method of manufacture are:

I. The weight of the leather produced. Since leather is sold by the pound, the tanner tries to press into the hide the maximum amount of tannin, tannin being much cheaper than hides.

Beyond a certain point, this extravagance of impregnation fails to increase the wearing qualities of leather and is therefore useless to the buyer.

II. The color of the leather produced and the adaptability of the leather for coloring.

III. The possibility of tannin being washed out through wear and tear. From chromium tanned leather even a boiling process will not remove the tannin.

IV. Quickness in filling orders and amount of capital required.

V. Cheapness of manufacture. The best leather is produced slowly only by use of materials rather poor in tannin.

G. Statistical notes.

I. One ton (2,240 pounds) of hemlock bark will tan 300 pounds of sole leather or 400 pounds of upper leather; 4 to 5 pounds of good oak bark are required to produce 1 pound of sole leather.

One acre of hemlock wood is said to yield about 7 cords of bark, and 1,500 board feet of timber are said to carry one cord of bark.

One acre of hardwoods will yield on the average not over one-half cord of chestnut oak bark.

One cord of chestnut wood yields one barrel of extract.

II. The price of bark at the tanneries ranges from $4 to $16 per cord. The cord of bark is not measured, but is weighed, 2,240 pounds being called a cord.

The price of a cord of chestnut wood f. o. b. cars is $2.50 to $3.

III. One hundred pounds of dry hides yield 150 to 185 pounds of leather; 100 pounds of green hides yield 60 to 80 pounds. The cost of the hide amounts to from 50% to 75% of the cost of production.

IV. The number of tanneries in the United States has greatly decreased from the year 1880 (5,628 plants) to 1900 (1,306 plants). The small tanneries using old fashioned and wasteful methods have been killed by the large and intelligently conducted modern plants. The leather trust controls over 100 of the largest plants.

The investment of capital has increased from $73,000,000 in 1880 to $174,000,000 in 1900.

The cost of raw material, $155,000,000, and the value of the product, $204,000,000, have remained almost unaltered during the same period.

V. "Hides" are obtained from oxen, cows and horses; "kips" from yearling cattle; "skins" from calves, sheep, goats and pigs.

Calf skin is used for upper leathers of shoes; sheep skin for cheap shoes, linings and gloves; goat skin for fine upper leathers and gloves.

Hides often are split and the so called grain and flesh splits are used in place of goat and calf skin.

H. Manufacture.

The old fashioned methods used from time immemorial consisted of rinsing skins; scraping off the flesh; treating the hair with lime; placing alternating layers of crushed oak bark and of skins in rough vats. The time consumed in this process of manufacture frequently exceeded a year. The best leather, however, is produced in this way.

The modern process in manufacturing sole, belt and harness leather is:

I. Soak in soft water (heated to less than 70° F.) to remove salt and blood and to restore the original softness and pliability of the skin.

II. Loosen hair by either liming green hide in milk of lime for three to six days or sweating dry hides at 70° in a close room, inviting a partial decomposition of the hair sheath. The sweating is preferred for acid hemlock tannage.

III. Remove on the "beam," by hand or machine, flesh, hair, blood, lime, dirt.

IV. Prepare the liquors in the leech house The liquors contain often from 5% to 6½% of tannin only. Cold water extracts only part of the tannin from either bark or wood. Very hot water may extract all, extracting with it, however, undesirable coloring matters and killing the fermenting microbes.

V. The tannage itself is either "Acid hemlock tannage" or "Non-acid hemlock, oak and union tannage."

(a) Acid hemlock tannage consists of:

1. Coloring in a dilute solution of tannin.
2. Placing skin for 2 to 4 days in a sulphuric bath (of 10% to 30%) by which the hide is swelled to a great thickness.
3. Placing the hide in a strong, concentrated solution of tannin.

(b) Non-acid hemlock, oak and union tannage (2-3 hemlock, 1-3 oak bark):

1. Treat the hide, to begin with, with very weak solutions of tannin.
2. Gradually increase thereafter the concentration of the liquors. If a hide is at once hung in a strong liquor, its outer layers only are tanned. The hide will not swell, and the inner layers will fail to be impregnated.

VI. The operations finishing the process of manufacture are: Washing; scouring off the so called bloom; stuffing (which means bathing in grease); drying; dampening and rolling under pressure; redrying; glossing on a brass bed by brass rollers.

## § XXXIII. CHARCOAL BURNING IN CHARCOAL KILNS.

A. Distillation of wood.

Destructive distillation of wood, under reduced admission of air, yields chemically the following proportion of substances:

I. 25 % of non-condensable gases, viz.:

| | |
|---|---|
| carbon monoxide | acetylene |
| carbon dioxide | propene |
| marshgas | ethylene |

II. 40% of condensable vapors, viz.:

| | |
|---|---|
| acetone | formic acid |
| furfurol | butyric acid |
| methyl alcohol | crotonic acid |
| methylamine | capronic acid |
| acetic acid | propionic acid |

III. 10% of tarry liquid, viz.:

| | |
|---|---|
| tar | cresol |
| creosote | phlorol |
| toluol | naphtalene |
| xylol | pyrene |
| cumol | chrysene |
| methol | paraffin |

IV. 25% of solid residue, viz.:

| | |
|---|---|
| charcoal | inorganic salts |

B. The kiln process.

In the kiln process of destructive distillation of wood, all of the above substances are allowed to escape unused, excepting the solid residue.

Modern technology succeeds in catching and utilizing several of the substances given under II and III, as appears from Section XXXV.

Still, the large majority of the charcoal commercially used is produced by the old and wasteful charcoal kiln.

C. Characteristic qualities of charcoal.

I. Charcoal has per cubic foot a larger heating power than wood.

II. Owing to its lesser weight, it is very cheaply transported.

III. Its freedom from sulphur and phosphates makes it valuable for metallurgic work (Swedish charcoal iron).

D. The work at the kiln.

I. For use in kilns, wood must be thoroughly seasoned, free from heavy knots. The billets must have equal length.

The kilns should be charged with one species and one assortment of wood only at a time.

II. The work consists of:

(a) Preparation of ground near water by leveling and hoeing the soil, by removing roots and stones, by raising the center of the circle to be occupied by the kiln about 10 inches over its circumference.

The diameter of the circle is from 15 feet to 30 feet usually. The best soil is loamy sand, which secures proper regulation of the draft.

The site should be protected from wind. Twigs are woven into a wind screen on the windward side, if necessary.

(b) Erecting the "chimney" by placing three or four poles of even height at one foot distance from a center pole, fastening them together to the central pole by withes.

The chimney is cylindrical if kiln is lighted from above, pyramidal if kiln is lighted from below.

The chimney is filled with inflammable substances (dried twigs etc.).

(c) Constructing the kiln proper.

The kiln should have a parabolic form. It consists of two or more tiers of billets placed almost vertically, the bark turned outward, the big end downward, the finest pieces near the chimney and near the circumference, the largest pieces half way between.

These tiers are topped by a cap, consisting of smaller billets placed almost horizontally. A cylindrical chimney extends through the cap. A pyramidal chimney is closed by the cap.

In the latter case a lighting channel is left on the ground running radially on the leeward side from the bases of the pyramidal chimney to the circumference. This channel, too, like the chimney, is filled with easily inflammable material.

(d) Stuffing all irregularities, interstices, cracks etc. showing on the outside of the kiln with small kindling.

(e) Covering the kiln by two draft-proof layers so as to exclude or restrict the admission of air.

1. The green layer, ½ to ¾ feet thick, made of green branches, grass, weeds and moss.
2. The earth layer, 4 inches to 6 inches thick, consisting of wet loam, charcoal dust etc.

   If kiln is lighted from below, a belt about 1 foot high running around the circumference on the ground is left without earth cover until fire is well started.

   The earth layer and the green layer are thoroughly joined by beating with a paddle.

   In large kilns a wooden frame (the armor) consisting of T sections is used to prevent the cover from sliding down.

III. The kiln is lighted early in the morning on a quiet day. The cylindrical chimney is stuffed up with wood from above and then closed on top by heavy covering after the fire is well started in the cap.

The lighting channel, in the case of a pyramidal chimney, is similarly stuffed and closed.

IV. The regulation of the fire and of the draft are the most important functions of the attendant who guides the fire evenly and gradually from the cap down to the bottom.

The means of guidance are:

(a) To check draft, increased earth cover.

(b) To increase draft, holes of about 1½ inches diameter punctured through the cover with the paddle reversed.

If wind is strong, all holes are closed and earth cover increased.

Cracks forming in the cover must be closed at once.

In dry weather the kiln is continuously sprinkled.

The kiln may explode if cover is too heavy and draft too strong.

The color of the smoke escaping through the punctures indicates the completion of the charring process above the holes (transparent bluish color).

The holes are then closed, and another row of punctures is made about two feet below the closed holes.

V. Refilling is required where dells are forming irregularly, while the kiln gradually collapses to half of its original volume.

For refilling, the cover over the dell is quickly removed, all holes having been closed beforehand, and the dell is rapidly filled with fresh wood.

VI. When the bottom holes show the proper color of smoke, the charring process is completed. All holes are then closed and the kiln is allowed to cool.

The duration of the charring process is from six days to four weeks, according to size of kiln. The contents vary between four and sixty cords.

VII. The kiln is gradually, beginning at the leeward side, uncovered, and the crust of earth, after hoeing, is thrown on again. The earth, trickling down, quenches the fire. After another twelve to twenty-four hours, preferably at night, the coal is taken out in patches.

Water must be ready at hand, since fire usually breaks out when coal is drawn.

E. Statistical notes.

The loss of weight in the charring process is 75 %.

The loss of volume is 50 %.

In America charcoal is sold by the bushel, a bushel weighing about 25 lbs.

F. Appendix.

In Norway, Sweden and Russia kilns of trapezium form are built of peeled logs 15 to 30 feet long.

The lighting channel runs lengthwise on the ground.

The kiln is lighted at the narrow end and covered with green branches and earth in the usual manner.

The side walls being almost perpendicular, the cover is held in place by slabs spliced against the walls. No refilling is required.

Fire is conducted from the top of the kiln at the big end toward the bottom of the kiln at the little end.

The process lasts six to eight weeks.

The billets are placed horizontally, skidway fashion, the largest billets being put in the center and the smallest at the head and at the foot of the kiln.

### § XXXIV. LAMPBLACK AND BREWER'S PITCH, AND THEIR MANUFACTURE.

The former is used in the manufacture of patent leather; the latter for pitching beer barrels.

A. Raw material is spruce rosin.

B. The process consists in a combined melting and pressing of rosin. The brewer's pitch runs out through a pipe connecting the bases of the melting vats with a cooling vat.

C. The solid residue remaining in the vats is slowly burned in an oven. The smoke passes through a cool room and into a smoke room, the top opening of which is covered by a common bag. In this room pine soot or lampblack is deposited. The draft is regulated by the attendant according to the shape or bulge which the bag assumes under the influence of the smoke.

D. Some turpentine can be derived at the same time if the vats are closed air tight and if the escaping gases are condensed in a worm.

### § XXXV. PYROLIGNEOUS ACID, WOOD (METHYL) ALCOHOL, AND THEIR MANUFACTURE.

A. Raw materials: These are, preferably, broad leafed species—beech, birch, maple—which must be thoroughly seasoned.

Heavy stuff is preferable, it is said, to small stuff.

B. Distillation: The process consists in a dry distillation of the wood, differing from the charcoal kiln process merely by allowing the gases to condense.

The distillation takes place in large horizontal iron cylinders, usually about 10 feet long by 5 feet in diameter, into which the wood is run on steel trucks. After closing the cap of the cylinders (admission of air reduces the output of pyroligneous acid) the cylinders are slowly heated to a redhot. The gases forming are led through long worm pipes into a condenser.

Not all of the gases formed allow of condensation. The uncondensable gases are conducted to the fire room.

At the bottom of the cylinder, tar is forming and is let out by a system of pipes into a collecting basin. Conifers yield more wood tar than hardwoods.

C. Further treatment.

The gases, condensed to a liquid a large proportion of which is water, are then treated with lime. Lime neutralizes the pyroligneous acid, forming acetate of lime.

The liquid is then redistilled, wood alcohol going over first, water next. The residue is boiled down in open pans to the consistency of a sugar, the acetate of lime of commerce. From it acetic acid and its salts are derived in chemical works.

D. The output.

One hundred volumes of air dry wood furnish up to forty-eight volumes of pyroligneous acid.

One and three-quarters cords of beech yield 2,650 pounds of liquids, 25 gallons of tar and 700 pounds of charcoal.

The 2,650 pounds of liquids furnish 200 pounds of acetate of lime and 9 gallons of 82% wood alcohol.

E. Use: Acetate of lime is used by the chemical industry in the manufacture of acetic acid and of the salts of acetic acid.

Wood alcohol is used largely in the manufacture of varnishes, dyes, celluloid and especially for heating. It is poisonous.

### § XXXVI. TRUE OR AETHYL ALCOHOL AND ITS MANUFACTURE.

A. Principle underlying the process.

Wood boiled under pressure in the presence of acids yields sugar (dextrose). This sugar, freed from the acid admixed, is allowed to ferment under the influence of yeast and changed into aethyl alcohol.

B. Raw material:

Cottonwoods, linden, yellow poplar are said to be superior to the heavy hardwoods as well as to conifers. Possibly chestnut wood, from which the tannin is withdrawn in tannin extract factories, may answer as a raw material. Unless sawdust is available, the wood is prepared, sawed and pounded as if it were to be used in the manufacture of chemical fibre.

C. Process:

The acid used does not enter into any chemical combination with the wood. It merely acts by its presence and is said to be most efficient when in statu nascendi. Sulphuric acid, sulphurous acid, hydrochloric acid or a mixture of these and similar acids are used.

The temperature of the lead-coated vats containing acid and wood is gradually raised to about 250° F. Hydraulic pressure is also applied, either before or after the boiling process. As a matter of fact, the partial conversion of cellulose into starch seems to be due to pressure—not to boiling. The acid is then neutralized and the temperature reduced to about 85° F. By the addition of yeast (fed on phosphates of potash and of ammonia) a violent fermentation of the sugar is started, ending within thirty-six hours, when the yeast has dropped down to the bottom of the vat while the sugar has been converted into alcohol.

The liquid is distilled and redistilled, yielding alcohol of any desired concentration.

The wood remaining—only 20% of its weight seems convertible into sugar—might be used for paper manufacture or as fuel for the boilers. Classen claims, after his methods, to obtain at least 30 % dextrose from absolutely dry wood.

D. Output.

One hundred pounds of dry wood are said to actually yield about 5 pounds of 96 % alcohol. The process of manufacture is far from being perfect. A number of chemists, notably Classen, are hard at work to further improve and to cheapen the process. Cheap alcohol—a fuel, a source of light and a source of technical energy—manufactured from wood will be a boon for household, industries and forest.

### § XXXVII. ARTIFICIAL SILK MADE FROM CELLULOSE.

A. History.

Artificial silk was first prepared by Hilaire de Chardonet in 1884. Today many patents and numerous factories to exploit them exist in the old country.

B. Process.

There are two main processes in use, namely:

I. A solution of nitrocellulose, a compound of nitric acid and cellulose in ether or alcohol, is pressed through minute capillary pipes, appearing in long, silky threads. Additional chemicals (methods of Vivier, Lehner) reduce or entirely destroy the inflammability of the product.

II. Pure cellulose is readily dissolved in a few chemicals only, notably in concentrated copper oxide dissolved in ammonia. This solution forms a waxy mass which is pressed through minute capillary openings and appears in the form of supple, long, silky threads, immediately entering a bath of sulphuric acid. Here cellulose is set free, now a solid thread, while blue vitriol and sulphate of ammonia result at the same time. The threads are spun exactly like threads of natural silk.

C. Qualities of product.

Artificial silk has an exquisite shine and is easily colored before the pressing process. The tearing strength of silk obtained from nitrocellulose, however, is now only 33% of that of true silk, its toughness only 45%.

Artificial silk is used on a daily increasing scale in silk weavings. New methods and modifications of manufacture continuously increase its chances as a substitute for natural silk.

§ XXXVIII. MANUFACTURE OF OXALIC ACID FROM WOOD.

A. Principle.

Any wood heated to about 400° F. in the presence of caustic substances yields, among many other products of disintegration, a goodly percentage of oxalic acid.

B. Raw material.

Any wood finely ground or pulverized, and especially sawdust and mill refuse, is well adapted to the process—oak as well as beech, pine, chestnut etc. Cottonwood is said to be rather poor as a raw material.

C. Process.

A mixture of caustic soda, caustic potash and sawdust is heated, under continuous stirring, in open-pans (½ foot deep and 6 feet square) by superheated steam or air. The temperature is gradually raised to 480° (not over) F., remaining at that figure for about 1½ hours. The melted mass, consisting of oxalate of sodium and of carbonate of potassium, is thrown into water and allowed to cool, when the oxalate forms a dough of minute crystals. This dough is freed from water by centrifugal power, then treated with lime and thereafter with sulphuric acid, with the result that gypsum is precipitated from a solution of oxalic acid.

D. Output.

One hundred parts of wood yield up to 80 parts of oxalic acid.

The quantity of output depends on proper mixture of caustic soda and potash, and on proper regulation of the temperature.

§ XXXIX. THE MAPLE SUGAR INDUSTRY.

In the sap of all broad leafed species considerable quantities of sugar are found. This quality is commercially important, however, only in the case of hard maple. In 1900 there were produced 51,000,000 pounds of maple sugar and about 3,000,000 gallons of maple syrup.

New York, Vermont and New Hampshire lead this industry. Seventeen percent of all granulated sugar made in the United States is obtained from the maple tree.

Vermont protects its maple sugar industry from counterfeits by State inspection and official stamp.

A. Tapping the trees.

I. Time. End of January and February is best.
Cold nights and hot days necessary for best results.

II. A hole is made, with an auger, ½ inch to ¾ inch in diameter, slightly slanting towards the entrance, to a depth of 2 inches to 8 inches, at a point 2 to 3 feet above ground. Holes on north side of tree said to be most productive. Holes 10 feet above ground do not yield any sap.

III. A wooden or galvanized iron spout (3 to 8 inches long with a hook at the end to suspend the bucket) is inserted into the hole.

IV. Buckets are emptied at least daily, as the sap ferments easily. The sap, poured into large tanks resting on sleds, is quickly taken to the sugar shed. Buckets must carefully be kept clean.

V. Production per tree is 4 lbs. of sugar per season. The season lasts not over a month. The trees are not affected by tapping, either in quality or vitality. A new hole is made every year.

B. Boiling process.

Immediately after gathering, the sap is boiled down in open pans.

I. Manufacture of sugar.

Syrup is boiled to the consistency of wax, poured into forms and stirred to prevent formation of large crystals. Crystalization takes about 12 hours. Fifty quarts of sap yield 2 lbs. of sugar.

II. Manufacture of syrup.

The sap is boiled down to a lesser consistency and at once canned or bottled.

### § XL. NAVAL STORES, THEIR PRODUCTION AND MANUFACTURE.

A. Statistics.

In 1902 the United States produced 600,000 bbls. of turpentine worth $13,200,000; 2,100,000 bbls. of rosin or colophany worth $4,200,000.

One acre of orchard yields in three years' tapping 25 gallons of spirits of turpentine, worth $8, and 800 pounds of rosin worth $4, at a labor expense and manufacturing expense of $10. Thus a profit of $2 per acre is left to the owner.

Orchards are leased actually at $1 to $2 per acre for three years.

B. Methods of orcharding.

I. Southern method (also Austrian method).

(a) Species used: Longleaf pine (used now down to 8 inches in diameter); Cuban pine; echinata (small trees preferred); after W. W. Ashe, also Taeda; in Austria, Pinus Austriaca.

(b) Operations of the first season:

1. Boxing: The tree is cut into, 8 inches above ground, with a narrow, thin-bladed "boxing axe." Usually two boxes to a tree, on opposite sides. Width of box is 14 inches; depth horizontally 4 inches, vertically 7 inches; height of the tip above the lip about 10 inches. Boxing takes place in January and February.

2. Cornering: Immediately after boxing the tree is "cornered." Cornering implies the removal of two triangular strips of bark and sapwood above the

box, running as high as the tip. The resulting grooves act as gutters for the rosin.

3. Hacking: Hacking or chipping begins in early March and is continued until October. The "hack" is a bent-bladed, sharp instrument which is used obliquely across the tree, producing a series of V shaped grooves in the outer layers of sapwood above the box and the corners. The points of the Vs stand in a vertical line over the tip. The surface thus scarified is called a face. The chipping removes ½ inch of sapwood. The face of the first season is from 18 inches to 24 inches high and always remains as wide as the box.

4. Collecting: The virgin dip accumulating in the box during the first season is dipped out seven or eight times; the rosin, hardened on the face, is scraped off.

(c) Operations of subsequent seasons:

In the following seasons, the face is gradually carried upward until the working becomes unprofitable.

The output of dip, now called yellow dip, decreases from year to year, with the increase of distance between freshly hacked face and box. The scrape preponderates over the dip.

Longleaf pine may be tapped for an indefinite number of years, if intermissions of a few years permit the trees to recuperate.

II. French method (Hugues system).

(a) Species used: Pinus maritima, which grows on the sand dunes fringing the western shore of France, is exclusively treated to this method.

(b) Operations:

1. Remove the rough bark around the tree to prevent pieces of bark from falling onto the face.

2. In early March make a scar close to the ground 4 inches wide and 1¼ feet high, removing 2/5 inch of sapwood. The instrument used is a bent-bladed, crooked-handled axe.

3. Insert a toothed collar, made of zinc or

iron, into an incision cut with a sharp curved knife at the bottom of the scar.

4. Hang a glazed earthen pot on a nail immediately under the lip of the collar. The pot is 5½ inches deep, 5½ inches wide at top and 3 inches wide at bottom.
5. Extend the 4-inch scar week by week upward until October, taking each time a thin layer of sapwood off the old face. The final length of the face reached in a number of years is up to 30 feet.
6. The collar and cup are moved each spring to the top of the preceding year's face.

The nailhole in the pot allows rainwater to run off, since water is lighter than crude rosin.

The pot is often covered with a wooden lid, the face itself by rough boards.

III. Dr. Charles H. Herty's gutter method.

(a) Applicability:

The method can be applied to bled or unbled trees. It has been tried by the Bureau since 1902 in the Southern pineries.

(b) Operations of the first season:

1. Use cornering axe to provide two flat faces 8 inches above the ground forming an angle of about 120°; each is half as high as long; total width about 14 inches. Two men, right and left handed, cut 3,000 faces per day.
2. Make incisions at base of faces, one at least an inch higher than the other. Tool used is a broad axe having a 12-inch straight blade.
3. Insert galvanized sheet iron gutters into the incisions. Gutters are 2 inches wide and 6 inches to 12 inches long, bent to proper form (angle 120°) by a tilting-bench contrivance. The lower gutter projects by 1½ inch over the mouth of the upper, the projection forming a spout.
4. Fasten an earthen cup of a capacity equaling that of a box (5½ in. x 3½ in. x 7 in.) on the side of the upper gutter in such a way that its rim stands ½ inch below the spout, and that the nailhole is as far as possible from the spout. The

nailhole should be two inches below the rim of the cup.

5. Chipping as in method I; cups emptied from time to time into collecting buckets.

(c) Operations of subsequent seasons:

Next season, the uppermost chipped channels are used for the insertion of the gutters. The cup is fastened at the upper end of the face made in the previous year.

(d) Equipment:

Equipment required for 10,000 boxes is: 10,500 cups (cost 1¼c each =$131.25); gutter strips made from 1,886 pounds of galvanized iron, 29 gauge (cost of material $103.27; cutting and shaping gutters cost $4); 10,000 six-penny nails (costing $1.05); freight charges are about $30; labor at the trees requires an outlay of $80.

(e) Results:

Dr. Herty justly claims financial superiority of this method over the old Southern method, due to an increased output of turpentine.

C. Manufacture of naval stores from pine products.

I. From rosin of longleaf pine etc.

(a) Melting crude rosin in order to separate from the liquid constituents pieces of bark, wood and a pitchy residue.

(b) Dry distillation of the latter in a copper distilling apparatus, heated usually from an open fire beneath the apparatus; but preferably from steam of high temperature.

(c) Cooling of gases in a worm and condenser where there are obtained:

1. An upper layer of turpentine which is redistilled.
2. A middle layer of rosin (colophany) of a light yellow color, which is sifted repeatedly into different qualities.
3. Water forming the lowest layer.

II. From roots, branches and stumps of pine, the stumps to be dug out a few years after the trees are cut.

(a) Cut the wood into kindling.

(b) Fill it (from above) into a gasproof brick still-room, 15 feet high and 6 feet through, holding from 5 to 6 cords of kindling. The top and bottom of the still are funnel shaped and provided with pipes. The still is surrounded by the fire room.

(c) After closing the upper funnel, apply heat very gradually. Within 24 hours turpentine begins to escape through the top pipe which leads through a worm into a condenser. When the gases appear dense and thick, the top pipe is closed and the gases (now largely containing pyroligneous acid) are forced through the bottom pipe to be condensed in another condenser. Light (at a later stage dark) tar is let out through this same pipe. The fires are checked when the tar begins to flow freely.

(d) The process takes, for heating, 3 days; for cooling, 8 days. Charcoal is left in the still room. Proper regulation of temperature is most essential.

(e) One cord of pine kindling yields about 25 gallons of tar, 1 to 1½ gallons of machine oil, ½ to 1 gallon of turpentine, some pyroligneous acid and ½ cord of charcoal.

III. Uses of naval stores:

(a) Spirits of turpentine are used for colors, paints, varnishes, asphalt laying, solvent for rubber.

(b) Colophany is used for glue in paper manufacture, varnishes, soap making, soldering, manufacture of sealing wax.

(c) Wood tar made of conifers is lighter than water (owing to spirits of turpentine therein contained); made of broadleafed is heavier than water. It contains tolnol, xylol, cumol, naphtalin, paraffin, phenol, kreosol, pyrogalol and many other carbohydrates.

Caustic soda causes the solution of the aromatic alcohols contained in wood tar. From this solution true creosote is derived.

Dry distillation of wood tar yields:

1. Light wood oil;
2. Heavy wood oil;
3. Shoemaker's pitch, a residue.

D. Conifers other than pines are used only to a limited degree in the manufacture of naval stores.

(a) The larch yields the so-called venetian turpentine, which is obtained by boring (with 1½ inch auger) a deep hole into the heart of the tree. The hole is closed by a plug. After a year the turpentine, entirely filling the hole, is extracted.

(b) Spruce was tapped for turpentine on a large scale in the old country before the orchards of the South were developed. Only scrape is obtained from long and narrow faces. The scar invites red rot, badly checking the value of the timber. The output in ten years is, per acre, 73 lbs. of crude spruce rosin.

(c) Fir has rosin ducts only in the bark. Blisters or bubbles of the bark filled with rosin yield the so-called "Canada balsam" and "Strassburg turpentine," collected in tin cans. The blisters are opened with the rim of the can.

## § XLI. VANILLIN.

Vanillin, a substitute for vanilla, which has caused the price of bean vanilla to decline rapidly and permanently, is obtained from spruce (fresh cut) by removing the bark and collecting the sap either with sponges or broad-bladed knives. The sap is then boiled, strained and condensed in the vacuum pan to one-fifth of its former volume.

In the cooling room, crystals of coniferine are formed from the syrup. Coniferine, when treated with potassium bichromate and sulphuric acid, is oxydized into vanillin. The syrup obtained as a by-product is distilled and used in the manufacture of alcoholic beverages.

Eighty gallons of sap yield one gallon of coniferine.

## § XLII. BEECHNUT OIL.

Mast years of beech occur, according to climate, every 3 to 8 years. The nuts are gradually dried, slightly roasted, peeled and cleaned of shells; then either ground, applying moderate heat, or pounded in mills by stampers. The oil oozing out is strained and placed in a cool room (in earthenware vessels), where the clean oil forms a top layer to be poured off gradually.

The residue is pressed into cakes and used as feed for stock.

Two hundred pounds of dry beechnuts yield 5 quarts of oil.

## § XLIII. PINE LEAF HAIR.

Pine leaf hair, or curled pine straw, is used as a substitute for wool and cotton in upholstering, carpets etc. The stuff is mothproof.

Three hundred to 400 pounds of needles yield 100 pounds of wool.

The price is $3 to $12 a cwt., according to the quality.

A by-product is known as pine needle extract, used by the perfumer.

The process of manufacture consists of:

Drying the freshly cut needles; steaming; fermentation; crushing and disfibreing in pounding mills; repeated washing of the feltlike mass; loosening on sets of oscillating sieves; drying and bleaching. The product has a greenish or yellowish color. It is called "pine hair" in North Carolina, where the industry, now extinct, promised a successful career twenty years ago.

§ XLIV. IMPREGNATION OF WOOD.

Impregnation tends to increase the durability of wood by injecting an antiseptic liquid and may mean a desirable or undesirable change of color, and in some cases fireproofing. Little is known about the latter.

Four principles may be applied:

A. Immersion:

I. The oldest method used was immersion in a strong solution of salt. European railroads place ties for eight days in large tanks filled with a light solution of corrosive sublimate. No other work required. The method is called "Kyanizing." Drawbacks are that the liquid is washed out on wet ground; that spikes do not hold well in the timber. Expense per cubic foot, 6½c.

II. "Metalized" wood is obtained as follows:

Immerse the wood in a solution of sulphate of iron; then smear the wood with chloride of calcium. In the outer layers of the wood gypsum (sulphate of lime) is formed together with chloride of iron. Such wood is impermeable to water and has a metallic shine.

B. Boiling:

I. Boiling in salt water or in a solution of borax seems to be a method rarely practiced. Boiling, however, with exhaust steam, when a black juice is forced out of the log, is frequently seen abroad.

In the latter case the log is practically steam dried.

II. "Franks" mixture consists of 95 % liquid manure and 5 % of lime. It is pumped into large vats, within which the wood is boiled for 3 to 8 days. The liquid enters to a depth of about 3 inches and darkens the wood to a mahogany tint.

III. A method called "siderizing" injects by a boiling process a solution of copperas. The wood is then dried, and liquid glass (a hot solution of silicate of aluminum) smeared on the surface. By a chemical reaction silicates of iron are formed in the outer layers, which are insoluble in water and resist decomposition. The wood at the same time obtains a beautiful gloss.

C. Use of hydrostatic pressure:

A solution of sulphate of copper (blue vitriol) is used after Boucherie. It is kept in a tank 30 ft. to 40 ft. above ground. The timber must be fresh cut with the bark on and is spread on a rough log-deck. At the big end of each stick a ring made of rope is held in place by a board or heading nailed to the log. A hose connected with the tank injects the liquid into the small cleft formed between log and heading. After a few hours, drops of vitriol appear at the small end, showing that the process is complete. The pressure being slight, only the outer sappy layers are impregnated. This method is largely used abroad, often in the woods themselves, for telegraph poles of pine, spruce, fir etc. Expense per cubic foot, 4c.

D. Use of steam pressure:

The wood is dried thoroughly, then placed on small steel cars running into long cylinders or boilers, closed by a strong head. A vacuum pump removes the sap water and causes a vacuum to form in the wood itself. Then an antiseptic liquid is pressed into the boilers; temperature of liquid is 150° to 200°.

The liquids used are:

(a) Chloride of zinc.

(b) Creosote or rather cheap coal tar oils.

(c) Gases of tar oils (so called thermo-carbolization).

The creosoting method is used for ties and paving blocks. Creosoted timber holds nails well; creosote is not washed out by rain; on the other hand, the darkened color of the wood is sometimes objectionable. It is claimed that creosoting in the United States has failed, probably because an extravagant amount of the liquid has been pressed into the timber. In Germany the expense per tie is only 63c as against $1.25 in the United States.

E. Results:

Heart wood is not as permeable and hence not as impregnable as sap wood. Maple, birch, beech, spruce, sappy pine etc. are more benefited by impregnation than white oak, longleaf pine etc. Generally the duration of life of impregnated ties is increased at the following ratio: Beech, 400%; yellow pine and oak, 200%; spruce, 50%.

Obviously, every additional pound of preservative pressed into the fibre has a lesser effect on the lastingness of the wood than the preceding pound. For every woody species the limit must be found at which additional impregnation proves unremunerative.

# Some Business Problems of American Forestry

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By C. A. SCHENCK, Ph. D.,

Forester to the Biltmore Estate, Biltmore, N. C.
Forest Assessor to the Grand Duchy of Hesse-Darmstadt, and
Principal Biltmore School of Forestry.

*A limited edition of 400 copies of this pamphlet has been printed. Copies will be mailed to any address at $1.00 each. Address orders with remittance to The French Broad Press, P. O. drawer 666, Asheville, North Carolina.*

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The French Broad Press, Asheville, N. C.

# PREFACE.

FORESTRY on a large scale will not be possible in the United States, on private holdings, unless it proves to be a remunerative investment of capital.

Unfortunately, owing to the slowness of treegrowth, there is no chance of large profits in forestry. Not one of the forest owners abroad has engaged in forestry with a view of getting rich through it. Forestry is not a maker of wealth; it is only a preserver of wealth.

As a preserver of wealth, forestry is unrivalled. No business yields interest on the capital engaged in it as steadily as forestry. As sure as the sun shines, the wind blows and the rain falls, the volume of a tree is compelled to increase, the increment representing the interest on tree-capital. Sunshine, air and precipitations are the factors of treegrowth.

Abroad, all aristocratic families owning forest-estates have succeeded in the maintainance of their standing for centuries, whilst the rich merchants and bankers of olden times have not left a trace of their names and their wealth, in spite of the fact, that many of them, the merchants of Leipzig, Hamburg, Midland, Nuernberg, were richer than their sovereigns themselves.

In America, it is the well-to-do class, and pre-eminently the well-to-do lumberman, who should be interested in forestry, wherever it offers him a safe and remunerative chance of investment.

The "Problems of Forestry" were compiled with a view of showing the American wood owners the financial character of professional forestry. The object in forestry, as in any other business, is the production of high and safe interest on capital. Some little knowledge of elementary mathematics and of banking generally is required for the solution of any financial problem. The banker, the insurance company, the stock broker, constantly meet with tasks similar to those outlined in the "Problems of Forestry."

The splendid interest tables issued by the Mutual Life Insurance Company were used for the solution of the problems in order to avoid the times-taking application of logarithms.

C. A. SCHENCK,
Forester to the Biltmore Estate.

Biltmore, N. C., March, 1900.

## TABLE OF PROBLEMS.

## A LONGLEAF PINE PROBLEM (FLORIDA).

PREMISES: Mr. S., of E., Florida, owns a pine forest of all ages, so that seedlings, saplings, poles and trees are equally mixed, and estimates that the annual growth is 250 feet board measure per acre. The tract is 100,000 acres and he thus cuts 25,000,000 feet board measure annually with the view of not decreasing the growing stock. The expense for taxes and the cost of protection from fire, etc., is 5c per acre per annum; the value of the stumpage is $1 per thousand feet board measure. Mr. S. thinks that the quality of the forest will be improved gradually, and expects an increase in productiveness, of one per cent. annually. He figures, besides, on rising stumpage prices, the rise keeping step with the increase in population (1½ per cent.). He has a chance to invest money at 5 per cent. in an equally safe manner and wants to sell the forest.

QUESTION: Below what price per acre is it not advisable for Mr. S. to sell?

POINTS:

1. Mr. S. must figure at 5 per cent. interest, as the equally safe investment promises him 5 per cent. as well.

2. If the productiveness of the forest increases by 1 per cent. per annum, and the stumpage price at 1½ per cent. per annum, the receipts will grow at the rate of 2½ per cent. per annum. In discounting these receipts backwards, we have to figure at 5 per cent. —2½ per cent. = 2½ per cent.

3. The present value of all annual receipts is $\dfrac{\$25{,}000}{0.050-0.025}$

4. The present value of all expenses (taxes and protection) is $\dfrac{100{,}000 \times 0.05}{0.05}$

EQUATION: $\dfrac{25{,}000}{0.050-0.025} - \dfrac{100{,}000 \times 0.05}{0.05} = X$

RESULT: $900,000 for the whole forest, or $9 per acre.

## ANOTHER LONGLEAF PINE PROBLEM (FLA.)

PREMISES: Near Pensacola, Florida, a tract of 50,000 acres stocked with longleaf pine, not boxed for turpentine, is for sale, the stumpage averaging 3000 feet board measure per acre. The present owner offers the stumpage alone at $1 per thousand feet, or else is willing to sell the fee simple (soil and trees together) at $3.50 per acre.

Under conservative lumbering, the annual production of timber is 133 feet board measure per acre, to be drawn from a growing stock of 1500 feet board measure per acre. The land itself is practically unfit for farming. No damage is to be feared from forest fires, as long as turpentine is not obtained from the forest. Figure at 6 per cent. interest, and at 1c taxes per acre per annum.

QUESTION: Is it advisable for a Pensacola mill firm, of twenty-five million feet annual capacity, to buy the stumpage alone, or is it more profitable for it to acquire stumpage and land together with a view of practicing forestry?

POINTS:

1. When buying the fee simple, the firm can cut, within three years, 1500 feet per acre—the biggest trees—leaving the balance of 1500 feet on the ground, and obtaining from that balance henceforth on an annual average as much as the annual accretion, namely 133 feet board measure (worth 13.3 cents) per acre.

2. Thus the firm obtains from the forest

(a) For three years annually 500 x 50,000 feet board measure worth $25,000.

(b) From the fourth year on, annually 133 x 50,000 feet board measure worth $6,650.

3. The expense for taxes will, for the whole tract, amount to $500 annually.

4. The firm paying $3.50 x 50,000 equal to $175,000 cash obtains assets worth $\frac{25000\,(1.06^3-1)}{0.06 \times 1.06^3} + \frac{6650}{1.06^3 \times 0.06} - \frac{500}{0.06}$

EQUATION: Entrepreneur's Gain

$$\frac{25000\,(1.06^3-1)}{0.06 \times 1.06^3} + \frac{6650}{1.06^3 \times 0.06} - \frac{500}{0.06} - 175000$$

$$= 25000 \times 2.67 + 6650 \times 14.0 - 500 \times 16.7 - 175000$$

$$= 66750 + 93100 - 8350 - 175000$$

RESULT: Bent on forestry, the firm seemingly incurs an undertaker's loss of about $25,000, paying more for the forest than the forest is able to refund.

If, however, the prices of stumpage can be expected to rise by 50 per cent. in the course of the next 20 years (corresponding with a rise of 2 per cent. per annum), acquisition of the fee simple at \$3.50 per acre implies a net gain of about \$33,600.

In addition it must be remembered that the tract, under destructive lumbering, cannot be logged over in less than six years, the mill capacity being 25 million feet board measure only.

Thus the firm, when engaging in ordinary lumbering, pays in fact more than \$1.00 per 1000 feet board measure, namely

$$\frac{\$150{,}000 \times 0.06 \times 1.06^6}{25{,}000\,(1.06^6 - 1)} = \$1.22$$

If this consideration holds good, acquisitiou of fee simple and practice of forestry is preferable even under stagnating prices, being by about \$11,700 superior to destructive lumbering.

## A RED FIR PROBLEM (OREGON).

PREMISES: Mr. W——r, a Michigan lumberman, had a chance to acquire, in 1862, 200,000 acres of splendid white pine forest, at 40c per acre. He had made 7 per cent. on the investment, and a total net gain of $1,200,000 when the last tree was cut in 1888.

In 1900 Mr. W——r moved to Oregon, and had a chance in the Cascade backwoods to exactly repeat the speculation of 1862, buying 200,000 acres of splendid Douglas fir, scaling 30,000 feet board measure per acre, at 40c per acre.

The value of the denuded land, in Michigan and Oregon, is nill. Taxes 1c per acre per annum.

QUESTION: What must be the development of stumpage prices in the section referred to, if Mr. W——r is again to make a net gain of $1,200,000 in addition to deriving 7 per cent. from the investment, in the course of 26 years?

POINTS:

The answer depends on the rate, at which the railroad system in the section will be developed, by the establishment of which the gradual removal of the timber will be made possible.

I. Suppose cutting begins after 16 years, in 1916 and ends in 1926.

1. The average cut will be 600 million feet board measure per annum, worth 600,000X. The receipts for stumpage, in 1926, will have accumulated to $\frac{600{,}000\,X\,(1.07^{10} - 1)}{0.07}$

2. The accrued expense for taxes will be, at 1c per acre per annum, $\frac{2000\,(1.07^{26} - 1)}{0.07}$

if we assume, that taxes on the whole land are paid until 1926.

3. The original price paid for the land, $80,000, has grown up, at 7 per cent. compound interest, to year 1926, to $80,000 x $1.07^{26}$.

EQUATION:

$$1{,}200{,}000 = \frac{600{,}000\,X\,(1.07^{10} - 1)}{0.07} - \frac{2000\,(1.07^{26} - 1)}{0.07} - 80{,}000 \times 1.07^{26}$$

RESULT: The stumpage price of Oregon pine, in that section, must average about 22 cents per 1000 feet board measure, from 16 years from to-day on.

II. Suppose cutting begins after 10 years, in 1910, and ends in 1926.

1. The average cut will then be $\frac{6{,}000{,}000{,}000}{16}$ = 375 million feet

board measure per annum. The receipts from stumpage in 1926 will have accumulated to $\frac{375{,}000 \text{ X } (1.07^{16} - 1)}{0.07}$

2. and 3. as under I.

EQUATION:

$$1{,}200{,}000 = \frac{375{,}000 \text{ X} (1.07^{16} - 1)}{0.07} - \frac{2000 \, (1.07^{26} - 1)}{0.07} - 80{,}000 \text{x} 1.07^{26}$$

RESULT: The stumpage price of Oregon pine, in that section, must average about 17 cents per 1000 feet board measure, from 10 years from to-day on.

## A YELLOW POPLAR PROBLEM (N. C).

PREMISES: A careful tally of the yellow poplar trees, standiug in the valley drained by Claw Hammer creek, furnishes the following data:

| | | |
|---|---|---|
| 1090 trees of 1½ foot diameter, containing 300 feet b. m. each, equal to . . . . . . . . . . . . . . . . . | 327,000 | feet b. m. |
| 1980 trees of 2 foot diameter, containing 450 feet b. m. each, equal to . . . . . . . . . . . . | 891,000 | " " |
| 860 trees of 2½ foot diameter, containing 700 feet b. m. each, equal to . . . . . . . . . . | 602,000 | " " |
| 680 trees of 3 foot diameter, containing 1000 feet b. m. each, equal to . . . . . . . . . . . . | 680,000 | " " |
| 270 trees of over 3½ foot diameter, containing 1700 feet b. m. each, equal to . . . . . . . . | 459,000 | " " |

The stumpage of these trees is worth, on an average,

| | |
|---|---|
| In the case of trees of 1½ foot diameter, . | $0.75 per 1000 feet b. m. |
| In the case of trees of 2 foot diameter, . . | 1.25 per 1000 feet b. m. |
| In the case of trees of 2½ foot diameter . | 2.50 per 1000 feet b. m. |
| In the case of trees of 3 foot diameter . . | 4.25 per 1000 feet b. m. |
| In the case of trees of over 3½ foot diameter | 6.25 per 1000 feet b. m. |

The trees, up to 2½ foot in diameter, are growing at a rate of 1½ inches in 10 years, and thereafter at a rate of 1 inch in 10 years.

The taxes are not apt to be reduced after the timber is cut.

The owner believes, that the price of poplar stumpage will double in 25 years (annual increase of 2½ per cent), and is satisfied to make 5 per cent on the investment.

QUESTION: At what rate shall the owner dispose of the trees, viz. down to what diameter limit is it advisable for him to sell the trees?

POINTS:

1. A tree of 1½ foot diameter, in 40 years, attains 2 foot diameter
A tree of 2 foot diameter, in 40 years attains . . 2½ foot diameter
A tree of 2½ foot diameter, in 60 years attains. . 3 foot diameter
A tree of 3 foot diameter, in 60 years attains . . . 3½ foot diameter

2. The 1½ foot tree, now worth $\$0.75 \times 0.300 = 22\frac{1}{2}$ cents, will be worth after 40 years $\$1.25 \times 0.450 \times 1.025^{40} =$ . . . $ 1.52
The 2 foot tree, now worth $\$1.25 \times 0.450 = 56$ cents, will be worth after 40 years $\$2.50 \times 0.700 \times 1.025^{40} =$ . . . . 4.72
The 2½ foot tree, now worth $\$2.50 \times 0.700 = 175$ cents, will be worth after 60 years $\$4.25 \times 1.000 \times 1.025^{60} =$ . . . 18.70
The 3 foot tree, now worth $\$4.25 \times 1.000 = 425$ cents, will be worth after 60 years $\$6.25 \times 1.700 \times 1.025^{60} =$ . . . . 46.80

3. All trees, growing at a 5 per cent. rate, are to remain; those growing at a rate of less than 5 per cent. will be cut.

EQUATIONS:

For 1½ foot trees: $0.225 \times 1.0X^{40} = 1.52$; $X = 5$ per cent.
For 2 foot trees: $0.562 \times 1.0X^{40} = 4.72$; $X = 5\frac{1}{2}$ per cent.
For 2½ foot trees: $1.750 \times 1.0X^{60} = 18.70$; $X = 4$ per cent.
For 3 foot trees: $4.250 \times 1.0X^{60} = 46.80$; $X = 4$ per cent.

RESULT: The owner should dispose of all trees having a diameter of 2½ foot or more, as they grow only at a rate of 4 per cent. Obviously, unsound trees which are apt to deteriorate, should be cut at once whatever the diameter be.

## ANOTHER YELLOW POPLAR PROBLEM (N.C.)

**PREMISES:** Pisgah forest contains 40,000 acres, stocked with 60 million feet board measure yellow poplar of superior quality, worth now $3.50 per thousand feet board measure. The owner expects that the prices of yellow poplar stumpage will double within the next 15 years (increase of 5 per cent. per annum), and that then small logs and defective logs will have a value as well, so that 70 million feet board measure will be available in the year 1915.

The taxes and the general expenses take six cents per acre per annum

The value of the soil, after the timber is cut, can be assumed to be $2 per acre.

The owner figures at 6 per cent. interest.

**QUESTION:** What is the profit from the investment, if any at the end of the next 15 years, aside from the interest of 6 per cent?

**POINTS:**

1. The present value of the investment is $60,000 x 3.50 for the trees and $40,000 x 2.00 for the soil.

2. The value of the forest in 1915 is $70,000 x 7.00 for the trees and $40,000 x 2.00 for the soil.

3. The running expenses from 1900 to 1915 are, per annum, $0.06 x 40,000. They accumulate up to 1915, to the sum

$$\frac{0.06 \times 40{,}000\,(1.06^{15} - 1)}{0.06}$$

**EQUATION:** $X = 70{,}000 \times 7.00 + 40{,}000 \times 2.00 - 1.06^{15}(60{,}000 \times 3.50 + 40{,}000 \times 2.00) - \dfrac{0.06 \times 40{,}000\,(1.06^{15} - 1)}{0.06}$

**RESULT:** The owner will find himself $182,000 short. He will lack a good deal from making 6 per cent. on his investment. As a matter of fact, he will make about 4 per cent. on the investment and no more, unless the stumpage prices do more than double within the next 15 years.

# AN ADIRONDACK PROBLEM.

PREMISES: A tract of land in the Adirondacks, acquired in the year 1876 at \$5 per acre, was cut over in 1888, yielding then, per acre, 1800 feet b. m. White pine, worth \$3 per thousand feet b. m., and 2600 feet b. m. Spruce, worth \$1 per thousand feet.

In the year 1896, there were cut per acre another 6550 feet b. m. of spruce, worth \$1.50 per thousand feet b. m.

The taxes on the forest were 5c per acre per annum; the expense of administration and protection 2c per acre per annum. Figure at 6 per cent.

QUESTION: At what cost were those last 6550 feet b. m. produced?

POINTS:

1. The price paid for the land, in 1876, was \$5 per acre, which accrued, at compound interest, and up to the year 1896, to $\$5.00 \times 1.06^{20}$

2. The running expenses, during the period 1876 to 1896, were 7 cents per acre per annum, and sum up to the amount of

$$\frac{0.07\,(1.06^{20} - 1)}{0.06}$$

3. The yield made in 1888 was $\$3.00 \times 1.8 + \$1.00 \times 2.6 = \$8.00$ Discounted forward to the year of calculation, 1896, this yield, (which is of course to be subtracted from the various outlays) amounts to $\$8.00 \times 1.06^{8}$.

EQUATION: $$X = 5 \times 1.06^{20} + \frac{0.07\,(1.06^{20} - 1)}{0.06} - 8 \times 1.06^{8}$$

RESULT: The cost of producing those 6550 feet was \$5.80. As the value of the 6550 feet is \$9.82, the owner has gained, aside from making 6 per cent. interest on the investment and aside from having the value of the culled forest for an additional asset, about \$4.00 per acre.

# A SPRUCE PROBLEM.

PREMISES: A spruce forest contains in the year 1899 per acre about 4228 feet b. m., consisting of trees scaling 10 inches or more at four feet from ground.

First case: Suppose that the owner actually cuts down to 10 inches diameter, thus removing now 4228 feet. Then, in the year 1929 he will be able to again cut 2420 feet b. m., cutting again down to 10 inches. Every 34 years thereafter he will have the same yield of 2420 feet b. m. The price of the stumpage is $1.40 per thousand feet. The taxes are, on an average, 3c per acre per annum.

Second case: Suppose the owner cuts only down to 12 inches. Then the forest will yield, to begin with, 3608 feet b. m. In the year 1919 the owner will be able to cut 2115 feet b. m., and thereafter the same amount every 24 years. The value of stumpage in this case is $1.50 per 1000 feet. The taxes are, on an average, 4c per acre per annum.

Third case: Suppose the owner cuts only down to 14 inches. Then the first yield will be, in the year 1899, 2846 feet b. m. In the year 1919 the owner will be able to cut 2624 feet b. m., and thereafter every 21 years the same amount. The value of the stumpage is $1.60 per thousand feet; the taxes are, on an average, 5c per acre per annum.

The owner wants to derive 5 per cent. interest and believes in a gradual increase of thc prices, the increase to average 2 per cent. per annum. The cost of administration and protection is in all cases 5c per acre.

QUESTION: Had the owner of the forest better cut down to 10 inches, to 12 inches or to 14 inches?

POINTS:

1. The maximum difference between expected yields and expected expenses determines the best course to be followed.

2. In the 10 inch case the yields are

$$4{,}228 \times 1.40 + \frac{1.03^4 \times 2{,}420 \times 1.40}{1.03^{34} - 1} = \$8.14$$

In the 12 inch case the yields are

$$3{,}608 \times 1.50 + \frac{1.03^4 \times 2{,}115 \times 1.50}{1.03^{24} - 1} = \$8.80$$

In the 14 inch case the yields are

$$2{,}846 \times 1.60 + \frac{1.03 \times 2{,}624 \times 1.60}{1.03^{21} - 1} = \$9.56$$

3. In the 10 inch case the expenses are $\frac{0.03 + 0.05}{0.05} = \$1.60$

In the 12 inch case the expenses are $\dfrac{0.04 \;+\; 0.05}{0.05} = \$1.80$

In the 14 inch case the expenses are $\dfrac{0.05 \;+\; 0.05}{0.05} = \$2.00$

EQUATION : $\underset{6.54}{(8.14 - 1.60)} \gtreqless \underset{7.06}{(8.86 - 1.80)} \gtreqless \underset{7.56}{(9.56 - 2.00)}$

RESULT: Cutting down to 14 inches only, the most conservative practice, pays best. It pays by \$1 per acre, better than cutting down to 10 inches, and by 50c. per acre, better than cutting down to 12 inches.

## ANOTHER SPRUCE PROBLEM.

PREMISES: A lumberman owns 20,000 acres of spruce land, from which he has just cut 6000 feet board measure per acre, 12 inch and over in diameter at the stump, worth $1.50 per thousand. After another 20 years he will be able to obtain 3320 feet per acre, cutting again down to 12 inch diameter, and we may expect, that, after 40 years, the same yield will be obtainable and so on.

The land, when cleared, is said to have some value for pasture purposes. The taxes are 4 cts., the expense for administration, protection, etc., 8 cts. per acre per annum. Figure at 6 per cent.

QUESTION: What is the forest worth at the present moment?

POINTS:

1. After 20, 40, 60 (and so on) years, a yield of 3320 feet b. m., worth $4.98 can be obtained.

2. The necessary expenses are 4 cents plus 8 cents per acre per annum.

3. The value of a forest, like the value of a house or a farm or a business is equal to the present value of all returns, minus all expenses, expected from it.

EQUATION: $$X = \frac{4.98}{1.06^{20}-1} - \frac{0.12}{0.06} = 2.22 - 2.00$$

RESULT: The forest, after lumbering, is worth 22cts per acre.

If the owner can sell it, for farming purposes, at over 22cts. per acre, he should certainly do it, provided that he can make, by re-investing the proceeds of the sale, 6 per cent. in an equally safe manner.

If the taxes, or the expense necessary for administration, protection, etc., are 2cts higher per acre per annum than is supposed in the premises, the owner had better give up the land after the first cutting, unless he can sell it, for in that case its forestry value is negative, the necessary expenses devouring all possible profits.

If, on the other hand, there is a good chance for the stumpage prices to rise, say at the average rate of 2 per cent. per annum, the cut over forest has a value of

$$\frac{4.98}{1.04^{20}-1} - \frac{0.12}{0.06} = \$2.15 \text{ per acre.}$$

The study of future prices of stumpage is of the very greatest importance for the wood-owner.

## A WHITE PINE PROBLEM (MINNESOTA.)

PREMISES: A Minnesota lumberman owns 10,000 acres of white pine forest, containing 6000 feet b. m. per acre, worth $3 per thousand. The agricultural value of the land is $5 per acre, when the timber is removed. Under conservative lumbering, an annual production of 300 feet b. m. per acre can be expected. Taxes 8cts per acre per annum. Protection from fire, under forestry, 12cts per acre per annum. Extra logging expenses, under forestry, $4 per acre, at the first cutting. Lumber prices expected to double in 35 years (= annual rise of 2 per cent.) Proper growing stock for forestry 2000 feet b. m. per acre.

QUESTION: What interest on the investment will forestry yield?

POINTS:

1. The investment, to begin with, is 6000 feet b. m. worth $3 = $18 per acre plus value of soil worth $5 per acre.

2. The yield under forestry is 4000 feet worth $3 = $12 per acre to be derived at once, and 300 feet worth 90cts to be derived annually thereafter, being the annual production of the 2000 feet left standing, per acre. The future yields are to be discounted at (X per cent. — 2 per cent.)

3. The annual expenses, under forestry, are 20 cents. The extraordinary expenses are $4 per acre, spent at the first cutting.

EQUATION: $18 + 5 = 12 + \frac{.90}{0.0\,X - 0.02} - \frac{.20}{0.0X} - 4$

RESULT: About 7 per cent.

# A SHORT LEAF PINE PROBLEM (ARK.)

PREMISES: The S. & A. Lumber Co., of B., Arkansas, owns 100,000 acres of forest stocked, per acre, with 6000 feet board measure merchantable short leaf pine, and has a mill of thirty million feet board measure annual capacity. The stumpage is worth \$1 per 1000 feet board measure. The land is unfit for agriculture. Under conservative cutting the forest will continuously produce 200 feet board measure per acre per annum, after the "Virgin Surplus" of the forest, consisting per acre of 4500 feet of hypermature and mature trees, has been removed. Under conservative cutting, the logging expenses are 10 cents higher per thousand feet board measure. Prices are expected to rise at 1 1-2 per cent per annum. Figure at 6 per cent. Taxes are 1ct per acre per annum. Protection from fire, under conservative lumbering, will cost 3cts per acre per annum.

QUESTION: Which pays better, conservative or exhaustive lumbering?

POINTS:

1. If prices rise at 1 1-2 per cent., future yields must be discounted back to the present moment at 6 per cent — 1 1-2 per cent equal to 4 1-2 per cent.

2. Under exhaustive lumbering, the forest will yield 30,000,000 feet b. m. for 20 years, and nothing more. The land, being non-agricultural, will be thrown away after 20 years. The value of all yields expected from the forest, minus taxes for 20 years, is therefore:

$$\frac{30000 \quad (1.045^{20} - 1)}{0.045 \times 1.045^{20}} - \frac{1000\ (1.06^{20} - 1)}{0.06 \times 1.06^{20}}.$$

3. Under conservative lumbering, we withdraw as well annually 30 million feet from the forest, as long as the mature stock of 4500 x 100,000 equal to 450 million feet lasts, namely for 15 years.

4. From the 16th year on, we cut only the annual production, namely, 200 x 100,000 equal to 20 million feet per annum.

5. As the extra logging expenses, in this case, are 10 cents higher, the timber has a stumpage value of 90 cents only, instead of \$1 per 1000 feet board measure.

6. Taxes and protection from fire will cost annually 0.04 x 100,000 equal to \$4000.

7. Thus, under conservative management, the present value of all expected yields, minus expenses for taxes and protection is:

$$\frac{27000\ (1.045^{15} - 1)}{0.045 \times 1.045^{15}} + \frac{18000}{0.045 \times 1.045^{15}} - \frac{4000}{0.06}$$

EQUATION:

$$\frac{30000\ (1.045^{20}-1)}{0.045\times1.045^{20}} - \frac{1000\ (1.06^{20})}{0.06\times1.06^{20}} \gtreqless \frac{27000\ (1.045^{15}-1)}{0.045\times1.045^{15}} + \frac{18000}{0.045\times1.045^{15}} - \frac{4000}{0.06}$$

$$30000\times13.0 - 1000\times11.\dot{5} \gtreqless 27000\times10.7 + 400{,}000\times0.5 - 66{,}700$$

RESULT: Conservative lumbering pays, by about $43,700, better than exhaustive lumbering.

# INFLUENCE OF FOREST FIRES ON RATE OF INTEREST.

PREMISES: Absolutely safe investments (f. i. U. S. bonds) yield about 3 per cent. interest on the principal.

Forestry in America is a less safe investment. Of course, trees live and grow as sure as the sun shines, the wind blows and the rain falls, for sunshine, air and rainwater are the components of wood fibre. Still the ravages of forest fires endanger both capital and returns from capital.

In the Southern Alleghanies, 2 per cent. of the woodlands, on an average, are annually damaged by fire. Nature will require 20 years for the restoration of the burned forest to its former value and productiveness.

QUESTION: What is the minimum rate of annual interest which forest-growth, under these conditions, must yield?

POINTS:

1. 98 acres out of 100 acres are left intact, 2 acres out of 100 acres suffer a reverse resulting in a setback of 20 years.

2. Hence the value of those 2 acres is reducd to $\frac{1}{1.0X^{20}}$ of what it was to begin with.

3. The growth of every 98 units of value left intact must make up for the loss through burning in such a way, as to bring the value of the total investment, at the end of the year, up to 103.

4. The 98 develop into the value 98 x 1.0X. This value, plus what remains of the 2 units damaged by fire, must be 103 if the investor shall make 3 per cent. on the original principal.

EQUATION: $98 \times 1.0X + \frac{2}{1.0X^{20}} = 103$

RESULT: 4 1-4 per cent. Unless those sections of the forest, which are left intact, grow at a rate of 4 1-4 per cent., the owner does not make 3 per cent. of absolute interest on the whole investment. It will pay the owner to annually spend up to 1 1-4 per cent. of the investment for forest protection, if by such expensive precaution fires can be entirely avoided.

Where fires result, on the annual average, in the entire destruction of 5 per cent. of the forest, the annual production on areas left intact must amount to at least 8.4 per cent. if the entire investment is to bring 3 per cent. interest. Such a production is impossible, unless the price of standing timber doubles within the next 15 years.

## STUMPAGE PRICES OF THE FUTURE.

PREMISES: Virgin forest is unproductive, because, annually, just as much timber is lost, through death and decomposition of trees, as there is produced under the influence of sun, rain and wind.

Cut over forest is, as a general rule, almost unproductive, owing to fires following the removal of the virgin growth.

Hence it is safe to say, that the annual production of timber in the 700 million acres of American woodlands is not over one-fifth of what it might be, (namely, 200 feet board measure per acre) and is not likely to exceed 40 feet board measure per annum per acre, or 28 billion feet board measure on the whole.

The total growing stock of timber in the United States is estimated to be 900 billion, and the annual consumption is estimated to be 39 billion feet board measure, (exclusive of firewood).

It is expected that, after the exhaustion of the American virgin surplus of timber, prices of stumpage will be at a level with those prevailing in No-Surplus countries, where, f. i., prime white oak stumpage is worth $75 instead of $3 here, and prime pine stumpage is worth $15 instead of $1.50 here, per thousand feet board measure.

QUESTION: At what annual rate can we expect the stumpage prices of oak and pine to rise, whilst our surplus is being gradually exhausted?

POINTS:

1. The annual consumption of timber exceeds the annual production by at least 11 billion feet.

2. Hence our surplus stock of 900 billion will be consumed in $\frac{900}{11}$ equal to 82 years.

3. After 82 years, stumpage of oak will be worth about 25 times, and stumpage of pine will be worth about 10 times of what it is worth now.

EQUATION: Oak: $3.00 \times 1.0X^{82} = 75.00$

Pine: $1.50 \times 1.0X^{82} = 15.00$

RESULT: The price of oak stumpage can be expected to rise at a rate of about 4 per cent. per annum; the price of pine stumpage at a rate of about 3 per cent. per annum.

## FOREST TAXATION IN THE UNITED STATES.

PREMISES: In America taxes depend on the value of property. In the less densely settled sections, where most of our forests are situated, the taxes amount to 1 per cent. of the property value.

Given a forest, which when 90 years old contains \$20 worth of timber per acre. The soil alone, when cleared, is worth only \$1 per acre. Rate of interest 4 per cent.

QUESTION: What taxes ought to be justly imposed upon the owner,—if taking 1 per cent. of the forest value is just taxation—at the 60th and 30th year of the development of the forest, and further, in the year, in which the seedlings were just starting?

POINTS:

1. The taxes being 1 per cent. of the value of the forest, that value—a prospective value—must be ascertained for the years 60, 30 and 0.

2. The forest 90 years old is worth \$21.00—\$0.21, the 21 cents being the amount of taxes due in the year 90,

$$\$21.00 - \$0.21 \text{ equals } \$\frac{99}{100} \times 21$$

The forest 89 years old is thus worth $\frac{\$\ 99 \times 21}{100 \times 1.04} - \frac{\$\ 99 \times 21}{100 \times 1.04} \times \frac{1}{100}$

equal to $\left(\frac{99}{100}\right)^2 \frac{21}{1.04}$

The forest 88 years old is thus worth $\left(\frac{99}{100}\right)^3 \frac{21}{1.04^2}$

The forest 87 years old is thus worth $\left(\frac{99}{100}\right)^4 \frac{21}{1.04^3}$

3. The forest 60 years old is thus worth $\left(\frac{99}{100}\right)^{31} \frac{21}{1.04^{30}}$

4. The forest 30 years old is thus worth $\left(\frac{99}{100}\right)^{61} \frac{21}{1.04^{60}}$

5. The forest 0 years old is thus worth $\left(\frac{99}{100}\right)^{91} \frac{21}{1.04^{90}}$

EQUATIONS:

Taxes in forest 60 years old $\frac{1}{100}\left(\frac{99}{100}\right)^{31} \frac{21}{1.04^{30}}$

Taxes in forest 30 years old $\frac{1}{100}\left(\frac{99}{100}\right)^{61} \frac{21}{1.04^{60}}$

Taxes in forest 0 years old $\frac{1}{100}\left(\frac{99}{100}\right)^{91} \frac{21}{1.04^{90}}$

RESULT: At 60 years 4 7-10 cent.
At 30 years 1 1-10 cent.
At 0 years 2-10 cent.

## INFLUENCE OF TAXES ON BUSINESS FORESTRY.

PREMISES: The premises are just as in foregoing problem.

QUESTION: To what figure do the taxes (paid from the first to the 90th year of the forest) accumulate up to the time at which the timber is mature, namely, up to the 90th year?

POINTS:

1. Taxes in the year 0 of the forest are

$$\frac{1}{100}\left(\frac{99}{100}\right)^{91}\frac{21}{1.04^{90}}$$ which, discounted to the year 90, amount to $\frac{21}{100}\left(\frac{99}{100}\right)^{91}$

2. Similarly, the taxes paid in the year 1 of the forest accrue to $\frac{21}{100}\left(\frac{99}{100}\right)^{90}$ and the taxes paid in the year 2 of the forest accrue to $\frac{21}{100}\left(\frac{99}{100}\right)^{89}$ and so on.

3. Thus the discounted values of the taxes form a geometrical progression of 91 numbers, with $\frac{99}{100}$ for the constant factor.

EQUATION: Sum of taxes equal to

$$\frac{21}{100}\left[\frac{1-\left(\frac{99}{100}\right)^{91}}{1-\left(\frac{99}{100}\right)}\right]=21\left[1-\left(\frac{99}{100}\right)^{91}\right]$$

RESULT: The sum of taxes paid, accrued at compound interest is \$12.60, and thus takes away 60 per cent. of the final yield obtainable.

It is especially noteworthy, that the rate of interest used does not influence the accrued sum of taxes in the least. The sum simply depends upon the number of years required to develop merchantable timber out of seedling trees.

It is safe to say that, under the conditions now prevailing in America, the taxes consume over one-half of the value of the yield derivable from forestry, if they are "justly" imposed. No wonder, then, that people are averse of engaging in forestry.

If the rotation is 150 years, the taxes curtail the final yield by 77 per cent!

## A NATIONAL PARK PROBLEM (MINNESOTA).

PREMISES: It is proposed to establish a national park in Northern Minnesota, on land unfit for farming, stocked with about 6000 feet board measure pine timber per acre, worth $2.50 per thousand feet board measure.

Four thousand feet board measure, per acre on an average, consists of mature or hypermature timber, whilst the balance is thrifty, and can be expected to yield by its own growth and by giving rise to a second growth, 150 feet board measure per acre per annum, under conservative management.

In this case the first logging expenses will by 50 cents per acre exceed the logging expenses under destructive lumbering.

Taxes, protection from fire and administration will take 10cts per acre per annum. Five and one-half per cent. interest.---Stumpage prices expected to double in 35 years (corresponding with an annual increase of 2 per cent.)

QUESTION: Will conservative lumbering, in this case, pay better than destructive lumbering?

POINTS:

1. Under destructive lumbering, the value of the forests is 6000 x 2.50 equal to $15 per acre.

2. Under conservative lumbering, 4000 feet are cut at once, and 2000 feet are left standing as a permanent investment, yielding annually 0.150 x 2.50 equal to 37½ cents per acre, from which figure, however, the annual expenses of 10cts must be deducted.

EQUATION: $15 \gtreqless 10.00 - 0.50 + \dfrac{0.275}{0.035}.$

RESULT: Under conservative lumbering, an enterpreneur's gain of about $2.50 per acre is obtained. Hence conservative lumbering pays better.

Unless the first logging expenses under forestry are by $3.00 per acre higher than is usually the case, destructive lumbering is financially inferior to conservative lumbering.

After destructive lumbering, the land is left worthless. Under conservative lumbering $10 are withdrawn from the forest, and there remains a permanent asset of about $8 per acre on the ground, yielding 5½ per cent. interest per annum.

## STATE LOANS FOR FORESTRY PURPOSES.

PREMISES: The state of P. decides to engage in state forestry, and to that end takes up a loan of $1,450,000, at 4 per cent., which is to be used as follows:

$1,000,000 for purchase of 1,000,000 acres at the headwaters of the rivers,

$ 50,000 for lawyer's fees, surveys, demarkation, etc.,

$ 150,000 for roads, etc.,

$ 250,000 for defraying the annual salaries of superintendents and rangers. After the road system is developed, 12 years from today, an annual revenue of 10 cents per acre per annum will be derived, under conservative management, and it is expected that this revenue will gradually increase at the rate of 3 per cent. per annum.

QUESTION: A: Within how many years will the forest itself be able to redeem the loan?

B: What is the forest worth after the loan is redeemed?

POINTS:

1. The annual interest on the loan is $58,000.

2. The revenue from the 12th year on is 0.10 x 1,000,000 = $100,000, of which $58,000 are used, from that time on, to pay the interest on the loan, whilst $42,000 or more are available annually for redemption of loan.

3. As the revenue rises at 3 per cent. per annum, the receipts are to be discounted at 4 per cent. — 3 per cent. = 1 per cent.

EQUATION:

$$A: \frac{42000\ (1.01^x - 1)}{0.01 \times 1.01^x} = 1{,}450{,}000$$

$$B: \frac{100{,}000 \times 1.03^{48}}{0.01} = X$$

RESULT: A: The loan can be entirely redeemed within 43 years after the 12th year, or within 55 years from today.

B: The forest, freed from all incumbrances after 55 years, and producing annually $356,000 with prospect of an annual increase of revenue equalling 3 per cent., is worth about $35,600,000.

If the people are ready to spend $58,000 for 12 years, they will gradually build up a very valuable forest.

Far-leading calculations in forestry might seem fallacious and absurd, if forest-history had not proved the very contrary.

## WEEDING AND ROAD-BUILDING.

PREMISES: Given a spruce forest in the Adirondacks, containing 50,000 acres stocked with 4,000 feet b. m. per acre. The forest is to be cut over at once in such a way as to reduce the average stumpage to 1,200 feet b. m., which are expected to produce thereafter 140 feet b. m. per acre per annum. Stumpage is worth \$1.50 per 1,000 feet b. m. Cuttings recur every 10 years.

QUESTION: A: Is it advisable for the owner, to remove, by way of an additional "weeding," the misshapen trees at an expense of 50 cents per acre, if by so doing the annual production can be raised from 140 feet to 175 feet b. m. per acre?

B: Is it advisable for the owner to build the skidding roads more solidly, at an expense of \$10,000 so as to make them available for future operations, and so as to be less dependent on the snow-covering, if by so doing the logging expenses per 1000 feet b. m. can be reduced by 5cts?

POINTS: A: The additional expense of 50 cents results in producing, every ten years, an additional 350 feet b. m. worth 52½ cents.

B: The additional expense of \$10,000, reduces the cost of logging, and hence increases the value of stumpage, by 5cts per 1000 feet. The first cut, therefore, of 50,000 x 2800 = 140,000,000 feet b. m., gains \$7,000; the subsequent cuttings, of 50,000 x 1750 = 87,500,000 feet b. m., gain \$4,375.

EQUATION: A: $0.50 = \frac{0.525}{1.0X^{10} - 1}$

B: $10{,}000 = 7{,}000 + \frac{4375}{1.0X^{10} - 1}$

RESULT: The "weeding" as well as the solid construction of roads are advisable, the former paying 7 per cent. and the latter 9½ per cent. interest on the additional outlay required. The advantage derived is greater still, if stumpage prices are on the increase.