VALUATION OF AMERICAN TIMBERLANDS

K. W. WOODWARD

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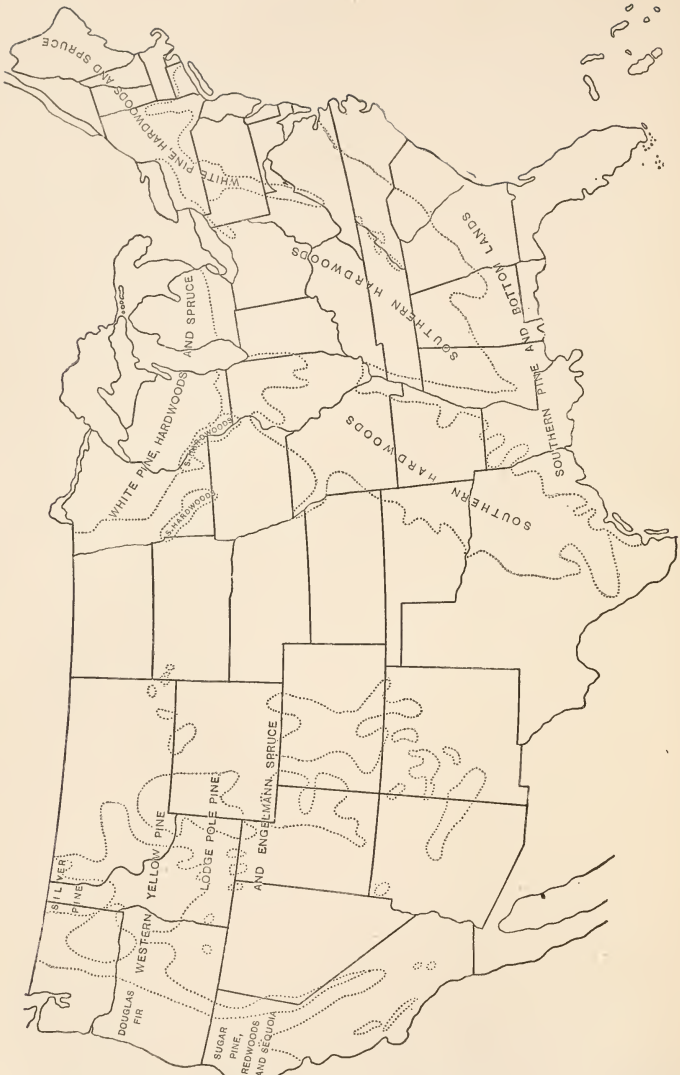

The Forest Types of the United States

Frontispiece

The Valuation of American Timberlands

BY

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To

DR. BERNHARD E. FERNOW

IN GRATITUDE FOR HIS HELP AND ENCOURAGEMENT AND ADMIRATION OF HIS ACHIEVEMENTS

PREFACE

This book is intended to supply certain information needed by the investor, timber cruiser and student of forestry. In other words, it aims to give for the continental United States and its outlying territories the principal facts regarding the timber resources. Hawaii has been omitted because its timber is useful mainly for its protective value and cutting in the commercial sense is only possible on a very limited scale. Likewise, the Canal Zone is not attractive to either the sawmill man or timberland investor by reason of the restricted area of American territory.

The investor will find data which will not only enable him to form a notion of what the examination of a tract should cost but he should also get the salient features of the general type of which his particular holdings are but a small part. This work tries to give those basic facts upon which a superstructure of detailed knowledge concerning a particular tract may safely be erected.

To the estimator or timber cruiser, likewise, it cannot take the place of first-hand observation as far as the appraisal of any given area is concerned. It should, however, show him what to look for and help him to keep that sense of proportion without which his reports may easily give a wholly wrong impression.

For the student of forestry it should fill an additional purpose. Few attempts have previously been made to gather together in one volume descriptions of the forest types of the United States. We have simply had detailed studies of isolated regions. With these latter as a basis, however, an attempt is here made to evaluate American forest conditions and compare the forest types with each other. This leads inevitably to the application of the principles which the student has learned in his courses in protection, silviculture, utilization and management. In other words, it is hoped he may here acquire some of the local color necessary to give vividness to the framework of fundamentals he has con-

structed in the classroom. The book was written to serve as supplementary reading in this way.

A forest type as here used is an area which has essentially the same climatic, topographic, and soil conditions, and hence tends in the long run to have the same composition. A subtype is a subdivision of a forest type in which the composition is uniform.

A word of explanation seems necessary in regard to prices now that the War has so radically disturbed all our preconceptions of market values. Obviously it is impossible to keep such a work as this absolutely up to date. Care has, however, been taken to give dates for all prices cited as that proper allowance may be made. In general it may be said that the prices of 1920 are roughly double those of 1915. Furthermore, wherever possible, costs are expressed in terms of man and horse hours as well as dollars.

Acknowledgment is, of course, due the Forest Service for its courtesy in allowing the free use of its large store of data.

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CHAPTER I

NORTHERN SPRUCE TYPE

General Conditions.— To this type of timberland belong the North Woods of Maine, the upper slopes of the White Mountains, the higher Green Mountains, the summits of the Adirondack and Catskill Mountains, and the northern swampy parts of Michigan, Wisconsin and Minnesota. Furthermore, a slender string of isolated spruce-clad peaks extends southward along the backbone of the Appalachian range and consequently some spruce is found in Pennsylvania, West Virginia, Virginia, North Carolina and Tennessee. The distribution of the type is shown graphically on the accompanying map.

Thruout its range spruce is most abundant in a cool, moist climate with long winters and heavy precipitation. Seldom is the growing season more than four months long and the annual precipitation must be at least 40 inches or supplemented by slow drainage. This means that there is an abundance of moisture available for tree growth because the long winters inhibit runoff and the cool summers are unfavorable to rapid evaporation.

These climatic conditions only occur on the steeper upper slopes of mountains and in flat swamp land. On both sites the soil is shallow but the spruce is well able to make the most of the scant foothold with its flat, widely extended root system. Likewise its common associates are trees of similar habit like the balsam, paper birch and yellow birch. However, by reason of its greater adaptability to such untoward conditions, spruce tends to crowd out its competitors and form nearly pure stands if given time enough. Hence the subtypes are generally transition types caused by fire or cutting. The more imporant of these and their composition by volume and number are:

COMPOSITION OF SUBTYPES — SPRUCE TYPE

Species	Virgin subtype		Cutover subtype	Burn subtype
	Number	Volume	Number	Number
	Per cent	Per cent	Per cent	Per cent
Spruce.....	60	80	10	10
Balsam.....	30	10	15	15
Paper Birch....	10	10	40	30
Pin cherry.....	.....	.....	35	45
	100	100	100	100

The virgin subtype varies considerably in composition with the altitude. At the upper edge of merchantable growth there is a large admixture of balsam, while at the lower edge where it merges into the hardwood type yellow birch and paper birch are the important associate species. The composition percentages given above are most representative of conditions in the middle of the altitudinal range of the type. There spruce is the dominant species, numerically and in volume, while balsam, paper birch and yellow birch are merely unimportant associates. An average stand is 10M feet B. M. per acre although stands of 20 or 30M are not uncommon. In the virgin subtype little damage is the rule, not because there are no serious enemies but for the reason that fire, insects and wind may wipe the subtype out, but they seldom affect it in a moderate degree. It is a case of total immunity or complete destruction. When the subtype is dry enough to burn the fire usually kills the young trees, jumps to the crowns of the older timber, and also eats up the shallow layer of soil. In the same way wind makes wide swaths or throws over the timber on entire mountain slopes if it once gets a leverage on a stand of spruce. Likewise, the great insect enemy of this species, the spruce beetle (*Dendroctonus piceaperda*) is a believer in no halfway measures. Working in large colonies it systematically kills all the timber that comes in its way. Fortunately little fungus damage occurs in this subtype.

The culled, cutover and burned subtypes are the result of

various degrees of lumbering and neglect on the virgin subtype. The culled stands are few for two reasons. In the first place even the early logging was comparatively clean because where it paid to cut the spruce on the upper slopes at all it was worth while taking nearly all the stand because it was of uniform size. The most recent logging has, of course, been clean because the demand for pulpwood furnished a market for all material down to a top diameter of four inches inside the bark. Furthermore in cases where culling has been attempted in the virgin spruce subtype much blowdown has invariably resulted and the final outcome been identical with clean cutting.

The cutover subtype is then the most common where the logger has reached the spruce type. Even the paper birch has often been cut in order that the spruce and balsam might be rolled down over it. As a result this subtype is usually completely stripped of its standing trees. What cannot be marketed is left to rot on the ground. Fortunately, however, tree growth quickly reëstablishes itself if fire is kept out. First, pin cherry and paper birch take possession of the ground and then spruce and balsam come up under their shade. If given time enough the two latter species distance the two first-named short-lived trees and the stand becomes nearly pure softwood. Furthermore, competition between the spruce and balsam is commonly more favorable to the former because of its greater persistence. The balsam is very subject to heart rot — *Polyporus schweinitzii* — and it is rare that a tree over 15 inches in diameter survives.

The restocking of the burned subtype is not rapid since fire is peculiarly destructive in the spruce type. Usually the weather is too cool and moist to permit fires to start but in droughts the thick layer of *humus* becomes very inflammable. Especially is this the case where logging has opened up the stand and left débris. Some of the most destructive fires in the unusually lurid forest-fire history of the American continent have been in the spruce type. Such fires are combined top fires and ground fires. Everything is consumed and only the bare rocks are left. Examples of the results of such fires are furnished by the bald summits of Monadnock, Chocorua and Baldface in the White

Mountains and the recently cutover and burnt slopes of Mt. Mitchell in North Carolina.

OPTIMUM GROWTH IN 100 YEARS

	Diameter	Height	Density	Yield per acre
	Inches	Feet	Trees	Board feet
Spruce	10	70	415	7400
Balsam	11	83	.....	.....
Paper birch	.....	.....	.....	5500

This table shows the optimum diameter and height growth for the important species in this type on a rotation of 100 years. The density and yield per acre are also given. From these it is evident that the short growing season is not favorable to rapid diameter and height growth and that the stands per acre are only heavy by reason of the great density of the trees. There is a marked difference between the northern spruce and southern Appalachian spruce. The latter grows faster in diameter and height but the trees do not stand so close together. Generally speaking the most profitable rotation for this type is at least 125 years.

Timber Valuation.— There are several factors which make estimating in the spruce type comparatively easy. The tracts are usually large so that boundary difficulties are not serious. Furthermore, the stands are uniform, the species few and damage slight. On the other hand the tracts are usually inaccessible so that the cost of subsisting an estimating party is high. Supplies frequently have to be brought in on men's backs because horses cannot be used off the roads. Even these are in many cases impracticable for hauling except when covered with snow. Another obstacle to cheap work is the roughness of the mountain slopes upon which the spruce grows and the density of the undergrowth. As a consequence an average day's work in this type is 24 strip acres — 1 chain (66 feet) wide and 240 chains long. However, only a small percentage of the tract need be actually covered in this way. Only on very small tracts is more than a

10 per cent estimate necessary. Ordinarily 5 to 10 per cent is sufficient because the tracts are large — over 500 acres — and the subtypes uniform in composition and density.

On account of the lack of roads and trails it is frequently difficult to find a suitable place for a base line from which to run the estimating strips. Usually, however, roads or trails are better than survey lines because they are easier to travel. When selected the base line should be surveyed and stakes set at equidistant points, measured in a cardinal direction and not along the base line. In fact the distance along the trail used may be several times that in a cardinal direction on account of the twists the trail makes to avoid rough going. From the stakes on the base line the estimate strips should be run across the valleys, preferably in a cardinal direction. The object in running them across the valleys is to avoid an overestimate by getting an undue proportion of the better timber in the valley bottoms. By using a cardinal direction possible compass errors are avoided because it is much easier to keep the line straight when a cardinal direction is used than when the lines are run at an angle less than 90 degrees.

This strip method of estimating is, of course, not the only way to determine the contents of a stand. It is, however, generally considered the best and its costs may fairly be considered standard. Obviously an experienced local estimator does not need to traverse a tract as carefully as one unfamiliar with the local conditions. He relies on his judgment more because he has had an opportunity to check it by the results of local logging. But his fees are based on the cost of a strip survey.

For spruce and balsam pulpwood is the use to which the smallest timber can be put so that the minimum merchantable limits for these species are determined by the sizes which the pulp mills will take. The present minimum standard is a stick four feet long and at least four inches in diameter at the top end. Since at least two such sticks must be obtained from a tree to pay for felling, trees less than six inches in diameter breast-high are considered unmerchantable. For sawtimber alone the limits are higher. At least six inches in the top and 10 inches breast-high are the usual requirements. Suitable tables giving

the volume either in cubic feet or board feet will be found in Hawley and Hawes' "Manual of Forestry," John Wiley and Sons, Inc., New York City. Only tables based on diameter breast-high and total or used lengths should be employed because there is great variation in the height of both spruce and balsam according to the depth of the soil.

For the other important species in this type, paper birch, yellow birch, beech and sugar maple, volume tables will also be found in the Manual of Forestry. With them total height is an unreliable factor and only usable length is a safe indication of their merchantability. This may be estimated in either 16 feet log lengths or in units of 10 feet according to the volume table and the way in which it is worked up.

The cost of estimating spruce tracts is determined first of all by the percentage of the stand estimated. As explained above this need seldom be more than 10 per cent on account of the uniformity of the stands. The second factor, roughness of topography, cuts down the area possible for a crew to cover in a day. However, 24 strip acres is a reasonable average day's work. Hence the work ought not to cost more than 15 cents an acre and can frequently be done for half that figure. This should include the preparation of a report showing the amount, quality and value of the timber, the way in which it can be logged and a contour map of the tract.

Stumpage Prices.— Stumpage prices tend to approach the difference between the cost of logging and manufacture and the average sale value of the lumber. Fluctuations in these factors are not, however, reflected at once in the stumpage prices. They are inclined to drag behind the increases in lumber prices and be unaffected by declines. This is well brought out by the following figures from Compton's "Organization of the Lumber Industry":

Average Stumpage Values for Spruce

	Per M
1890	$1.74
1899	2.26
1904	3.70
1907	5.49

Hence, for the calculation of future prices such figures can only be used as a check and guide. The costs of the different steps in logging and manufacturing must be known for each tract and the sum of these plus a margin of safety deducted from the average sale value. This requires a knowledge of the methods of lumbering and sawmilling and makes necessary their description in some detail.

On account of the inaccessibility of the spruce stands logging jobs are almost invariably carried on by large camps located close to the place of cutting and only connected with the outside world by a slender thread, the rough tote road. Spruce stands are usually in mountainous regions where farms cannot be hewn out of the wilderness. Consequently their logging is no job for the farmer's spare time. If he does it at all he must go back into the mountains, build a camp and stay with the job with single-hearted devotion. As a matter of fact the typical operation is a large one in which the camps house 30 to 60 men and such a one will be described to give a notion of the methods employed.

The first step is the estimate of the watershed or valleys to be logged and the accumulation of sufficient topographic data to determine where the main roads must go, whether driving can be employed and the approximate cost of logging. This information should be secured by the estimators. The figures given above for the cost of estimating contemplate a report which should cover the following points: —

Amount of timber by logging units.
Quality of timber by logging units.
Topographic data (preferably in the form of a contour map).
Logging costs by principal watersheds.
Method of sawmilling and estimate of cost.
Estimated sale value of finished product.

Such a report enables a lumber company to plan its own operations intelligently or let contracts with exactness. The latter method is more common in Maine, New Hampshire, Vermont and New York because there are many jobbers who possess great

skill in this work. In fact they are generally able to log more cheaply than the lumber companies themselves because their supervision is closer, their overhead expenses are small, they make scant allowance for depreciation or interest on investment and are content with small returns per thousand feet. In the southern spruce regions conditions are different. Seldom have the local inhabitants acquired the experience necessary to contract for themselves so that the lumber companies are forced to run their own camps. For simplicity's sake a contract job in the Maine woods will be taken as the type and after it has been described local variations in other parts of the country pointed out.

Assume then that Bill Jones contracted in 1914 to yard on the river bank of the nearest drivable stream two million feet of spruce and balsam. Since the haul from the stump to the yard was only four miles he agreed to do it for $5 per M. He needed a crew of 60 men and started felling by October 1 in order to get the timber down and skidded before the deep snows came. For his labor he hired his neighbors as far as possible and then filled in with French Canadians who came south for the winter after the Canadian harvest had been garnered. A picked crew of choppers was first sent into the woods to build camps and clean out the roads. Then the main crew came in. It was divided up into choppers, teamsters for the skidding teams, tote teamsters, barn tenders, a cook and cookees, a blacksmith, a scaler, camp clerk.

The first job was to fell the timber and bunch it up for hauling on two sleds. The methods employed varied with the steepness of the ground. On level and moderate slopes ordinary skidding practices were followed. A single horse or a pair bunched the logs on to skidways from which they could be rolled onto two sleds. On steep ground the procedure was different. Two sleds could not be used to advantage. The only safe way was to drag the log out on a single bobsled with only one end of the logs up. Bare ground was preferable to snow because slower and hence safer. Furthermore, the spruce commonly stood so densely on such steep slopes that it was easy to make up a bobsled load by merely rolling the logs onto the sled without any preliminary bunching. In fact in many places the timber was

felled into the roads which were not more than 100 feet apart so that the horses did not need to get out of the road. For example, on the Henry operations in the White Mountains and the Perley and Crockett job in North Carolina two sleds were not used at all. A single bobsled brought the logs off the mountainside directly to the railroad. On less steep ground, however, the two-sled is the standard method of getting the logs from the skidways to the railroad, drivable streams or mill. This sledding can, of course, only be done after there is plenty of snow. Hence the usual practice in the North Woods is to complete the felling operations by Christmas if possible and then put in January and February hauling. This gets the logs out of the woods before the river opens in the spring and ready for the drive in March and April.

The following figures were average costs, in 1915 :

	Per M
Felling and bucking	$1.50
Skidding	2.00
Hauling to railway or river, 2 miles	2.00
Drive or railway haul to mill, distance 10 miles	1.00
	$6.50

Felling costs are relatively high because the timber is small and usually found on rough ground. Skidding is shown as a separate cost altho as explained above it is frequently merged into the hauling as a single operation of "yarding." A charge for two-sledding to the railway or drivable stream is included to make the estimate conservative although sometimes it is possible to yard directly into the drivable stream or railway with a bobsled. Likewise, the distance taken for the railway haul or drive is rather longer than the average to avoid the possibility of having costs which are too low.

Expressed in terms of man hours and horse hours per M these costs would be as follows:

	Man hours	Horse hours
Felling and bucking	3	
Skidding	3	4
Hauling, 2 miles	5	7
Driving or railway haul, 10 miles	4	
Total	15	11

To attain these figures the felling crew must cut 6M per day if composed of two men and 9M if there are three men. In skidding this assumes that one team will bunch at least 5M board feet per day. The hauling costs are on the basis of a daily output of 3M board feet or five round trips hauling between 500 and 600 board feet each time. The driving and railway haul costs cannot be expressed conveniently in terms of a day's work but the figures given are at least conservative. In all the operations except hauling by railroad the labor costs constitute 80 to 90 per cent of the entire charge. On account of the large amount invested in rolling stock the labor costs are but 40 per cent of the cost of operating a railroad.

For pulpwood there is a well established market in the log form so that it need not be followed further than the mill. Prices ranged before the War from $7 to $10 per cord unpeeled. Peeling usually increased the price a dollar a cord. For converting board feet into cords a factor of 500 board feet is safe or in other words there will be found to be about two cords of pulpwood in a thousand feet of logs. Accessibility is the main factor in pulpwood values. New York State with a shorter freight haul for its paper pays better prices for pulpwood than New Hampshire or Maine.

Spruce destined for sawtimber cannot be safely valued in the log but must be carried thru the sawmill. Then its value becomes a simple matter because eastern spruce is well graded with Boston and New York as the principal wholesale markets. Milling charges added approximately $3 per M to the costs of logging so that exclusive of stumpage spruce lumber should not have cost above $10 per M to get ready for the market. The prices paid in October, 1916, at Boston for the principal grades of spruce were as follows:

	Per M
Frames 8 inches and under	$28.00
Random	22.50
Cover boards	20.50

The average price, however, was seldom over $25 per M because it was unusual to get more than 40 per cent of frames. A diagram showing the recent changes in spruce lumber prices is given in Fig. 3.

Yellow pine	10,845,000,000 bd. ft.
Douglas fir	5,820,000,000
White pine	2,200,000,000
Oak	2,025,000,000
Hemlock	1,875,000,000
Western yellow pine	1,710,000,000
Spruce	1,125,000,000
Maple	815,000,000
Gum	765,000,000
Cypress	630,000,000
Redwood	443,000,000
Chestnut	400,000,000
Birch	370,000,000
Larch	355,000,000
Beech	290,000,000
Yellow poplar	290,000,000
Cedar	245,000,000
Tupelo	237,000,000
White fir	213,000,000
Basswood	200,000,000
Elm	195,000,000
Cottonwood	175,000,000
Ash	170,000,000
Sugar pine	111,000,000
Hickory	100,000,000
Walnut	100,000,000
Balsam fir	82,000,000
Sycamore	30,000,000
Lodgepole pine	12,000,000
All other kinds	60,000,000
Grand total	31,890,000,000

Fig. 1

Lumber Production, 1918
Computed by U. S. Forest Service. Bulletin 845.

As stated above the stumpage price of any tract should be the difference between the average sale value of its timber and all costs of logging, manufacture and selling. On small jobs such

FIG. 2. Distribution of the Northern Spruce Tpye

calculations are simple but where large initial investments are necessary for railroads, roads, driving improvements, mill machinery, etc., the problem is exceedingly complex because the

exact influence of interest and depreciation must be determined. The most complete discussion of this subject is to be found in the U. S. Forest Service Stumpage Appraisal Manual. For our purposes it is sufficient to state the principles involved. Actual stumpage values for spruce and balsam range all the way from $2 to $8 per M according to the accessibility of the tract in question. Between 1900 and 1907 there was an increase from $2.26 to $5.49 per M, or a rise of 143 per cent. The percentage of balsam also influences the stumpage price of a tract. Fortunately, however, this inferior species seldom makes up more than 25 per cent of the total stand except in immature stands only large enough for pulpwood. It is a relatively short-lived tree which has to yield in the long run to spruce. Consequently there is seldom enough to greatly depress the value of a tract.

Land Values.— Land values in this type are impossible to determine from current sales because the timber is never sold separately. However, members of the New Hampshire Timberland Owners' Association have agreed to the taxation of their clean-cut lands at $2 per acre so that that figure may be used as a minimum valuation. From the productive aspect it is easy to show that spruce land is worth at least $3 an acre using a 3 per cent interest rate and assuming that there will be a yield of 15M feet in 100 years worth $150 an acre. Losses from insects, fungi, etc., will be offset by possible intermediate yields from thinnings.

Very little of the soil in the spruce type has any value for agriculture. Even as pasture in the Southern Appalachians it is not a success. The soil is so thin and the slopes so sharp that grass takes hold very slowly and cannot prevent washing. Furthermore, the climate is so rigorous that only the hardiest northern crops can survive. However, arguments and illustrations of this kind are superfluous. The facts prove the case. Scarcely 1 per cent of the entire type, north or south, has ever been cleared up for either tillage or pasture in spite of the keen demand for agricultural land that there has been in the northeast and southeast.

Titles.— Title questions are relatively simple because the tracts involved have usually been handled in large units. There have

commonly been grants of thousands of acres issued to one patentee. Hence their history is easy to trace. Claims of title are, however, sometimes obscure from the fact that the tracts of

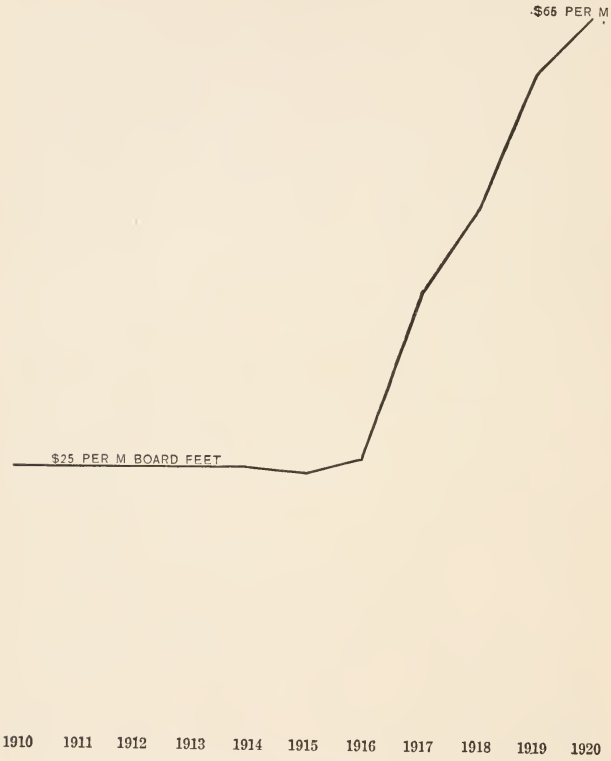

FIG. 3. Wholesale Prices of Spruce Frames, 1910–1920, Boston, Mass.

mountain land upon which spruce grows have only recently had a merchantable value and their early owners were lax in recording transfers and alienations. Breaks in the chain of title are not uncommon either due to simple failure to record sales and

bequests, thru the unperfecting of the claims of minor heirs, or because of unliquidated liens. Squatters also form another frequent source of annoyance. In many cases they have been allowed to use unmolested parts of large tracts for such long periods that they have acquired rights of possession.

CHAPTER II

NORTHERN HARDWOOD TYPE

General Conditions.— This is the type of timber which lies immediately below the spruce type — the beech, birch and maple belt. It is seldom abundant above 3000 feet above sea level but is the important type in northern Maine, the lower slopes of the White and Green Mountains, the Adirondacks and Catskills, and is represented southward along the backbone of the southern Appalachians by isolated islands of timber. In the Lake States it is found in Michigan, Wisconsin and Minnesota.

The climate is characterized by a longer growing season than that of the spruce type, less precipitation, more rapid runoff and flyoff and hence less available moisture. Only two of these climatic factors may be expressed absolutely. The growing season is at least four months and the total annual precipitation exceeds 35 inches. The other factors have not yet been accurately measured so that only comparative statements may be made.

Since the type occupies lower elevations than the spruce type the slopes are less precipitous, the surface less stony and the soil deeper. The absolute range in elevation varies, of course, with the latitude. In the northeast a range between 2000 and 3000 feet in elevation is the rule, while in North Carolina the northern hardwoods do not occur below 3000 feet above sea level. On south and west exposures the type does not extend so low but reaches higher elevations on account of the longer growing season as compared with northern and eastern exposures.

The greater depth of the soil as compared with that of the spruce type has already been mentioned. This would naturally follow from the fact that the hardwoods are further down the slopes where the accumulation of talus is deeper. They flourish particularly well on the southern slopes of the White and Green Mountains, the Adirondacks and the Catskills where the glaciers

have dumped piles of detritus scraped off from the northern slopes of the mountains. The composition of the soil varies with the geological history of the region. In the north it is of glacial

FIG. 4. Distribution of the Northern Hardwood and White Pine Types

origin, usually a loam with many boulders. South of the continental terminal moraine the soil is mainly derived from the decomposition of the underlying rock. But whatever its origin

it tends to become a rich, dark loam by the disintegration of the abundant leaf litter.

While beech, yellow birch and sugar maple are the characteristic species in this type there is always a generous admixture of other species. On the lower edges of the type white pine, hemlock, black birch, basswood, red oak, and even occasionally white oak are part of the mixture while at the upper margin spruce, balsam and paper birch are the supplementary species. It is seldom, indeed, that this type does not have a considerable percentage of softwood timber. In fact it is here that white pine and spruce reach their best development. For example, while the sand plains of northern Michigan produce the dense stands of pure white pine the largest, tallest and straightest individuals grew amongst the hardwoods.

A variety of subtypes may be distinguished in this type. In the first place there are the variations due to composition. These are mainly the results of differences in elevation. For example, a mixture of white pine and hardwoods is not common higher than 2000 feet above sea level because white pine does not flourish at a greater elevation. The distribution of spruce is governed by the same factor, it being unable to compete successfully with other species at elevations less than 2000 feet above sea level except occasionally on old fields. A few of the more usual combinations which it is useful to distinguish as subtypes on account of their composition are:

Hardwoods and white pine.
Pure hardwoods.
Hardwoods and spruce.

These are arranged in order of their occurrence starting with the lower limits of the type.

Besides the differences in composition due to elevation, lumbering, clearing, and fire have also played an important role. Stands may be virgin, culled, cutover, or burnt. Each has a different composition. Culling has been the commonest form of lumbering because in many places only the softwoods have been merchantable. This has naturally resulted in increasing the percentage

of the hardwoods in a marked degree. The composition of the cutover and burned subtypes except where the soil has been entirely consumed tend to be identical. Commonly such intolerant, light seeded species as popple, pin cherry and paper birch take possession of the ground. Then when they have reached a height of 10 or 15 feet the more tolerant hardwoods and spruce and balsam work in underneath. Occasionally, however, dense groups of hard maple crowd out the other species, especially where the maples have been cut and regenerate from sprouts.

A not infrequent variation in the older parts of New England is the old field spruce subtype. This is 90 per cent or more pure spruce in composition and is always found on old pasture. The grazing kept the hardwoods out while the seed bed conditions were favorable for spruce.

Fortunately damage is relatively slight in this type. None of the subtypes are as subject to burning as stands with a higher percentage of softwoods. Wind seldom succeeds in overthrowing the mixture of deep rooted species. Game, insects and fungi never cause the death of trees over wide areas because the stands are not made up of one species. In other words their food supply is too scattered, for usually but one kind of tree is attacked.

The following table gives data on the growth of the principal species of the hardwood type from the researches of the U. S. Forest Service and the State Forester of Vermont:

OPTIMUM IN 100 YEARS

Species	Diameter	Height	Density per acre	Yield per acre
				Cubic feet
Spruce	12	80	300	10,000
Hard maple	12	75	.....	.....
Aspen	23	89	60	13,000
Yellow birch	12	74	.....	.....
Vermont hardwoods	10	85	275	7,000

Timber Valuation.— Estimating within the hardwood type is a complicated problem. While the tracts are usually located on the lower slopes of the mountains, and hence the going is not

rough and roads not far distant, there are the following difficulties to be overcome:

1. Small size of the tracts.
2. Great variation in composition of subtypes.
3. Large number of species with varying uses so that different diameter limits must be employed in estimating.
4. Low branching habit of hardwoods so that the usable length is very variable.

It is unfair to generalize and say that all tracts in this type are small, but certainly they average less in acreage than tracts in the spruce type. The very good reason for this is that the hardwoods occur on the lower slopes near the farmland and hence were more desirable as woodlots in the early days. Then too the prime use of a woodlot 50 years ago was for firewood, and softwoods don't make first class fuel. These two factors of greater accessibility and higher-use value led to the early subdivision of the hardwood type into lots of 50 acres or more. Seldom is it possible to find a tract composed of units of more than 100 acres to the lot. Large grants of 500 or 1000 acres such as are the rule in the spruce type never occur. This factor of area is merely one of the reasons why a relatively large percentage must be covered in the estimating strips because a low percentage of a large tract will give as good an average as a much greater proportion of a small tract.

Still another reason for running the strips close together is the great variability in composition. There may be a small pocket of white ash in one corner of the tract which will greatly inhance its value but which would not be discovered unless an unusually careful search were made. Other valuable species tend to occur in small groups also so that nothing less than a 10 per cent estimate is safe even for tracts of 500 acres or more. With smaller blocks an even higher proportion is necessary. For example, at least 50 per cent should be actually measured if a true estimate of a 10 acre lot is to be secured.

The placing of the base line and the planning of the strip work present no unusual difficulties but follow the principles outlined

in the discussion of the spruce type. There are, however, a series of special problems in the determination of the diameter limits to be used in estimating. Each species has its own peculiar uses and hence there is wide variation in the part of the tree which is merchantable.

The principal uses of the species found in the hardwood type are as follows:

White pine — doors, sash, finishing lumber, and boxboards.
Hemlock — dimension lumber, rough finish, pulp and boxboards.
Spruce — dimension lumber and pulp.
Balsam — pulp.
Paper birch — shoe pegs, toothpicks, spools and bobbins.
Yellow birch — flooring, spools, bobbins and interior finish.
Black birch — flooring, spools, bobbins and interior finish.
Beech — flooring, spools, bobbins and interior finish.
Chestnut — rough finish, caskets, poles, railway ties.
Red oak — furniture, car stock, and railway ties.
White oak — furniture, car stock, and railway ties.
Hard maple — flooring, bobbins, spools, furniture, and shoe lasts.
Soft maple — flooring and bobbins.
Basswood — boxes, trunks, furniture backing and novelties.
White ash — handles and sporting goods.

The uses and diameter limits for spruce and balsam have already been discussed. White pine and hemlock are also salable for pulp so that the same minimum diameters hold altho these species usually find a better market if sawn into boxboards or square-edged lumber. If they are to be sold in the latter form a minimum diameter of ten inches breast-high and a top diameter of five inches will include all the merchantable timber. Barring certain special uses the hardwoods may be grouped into two classes, those manufactured into boards and those sold by cubic measure. Into the first class fall the maple, birch and beech which go into flooring and finishing lumber while the second class includes paper birch to be used for toothpicks and shoe pegs,

yellow and paper birch, beech and maple for manufacture into spools, bobbins or dowels. Naturally this latter class can utilize smaller sizes. The minimum estimating diameters for the different species found in this type are as follows:

MINIMUM DIAMETERS

LUMBER

Species	Breast-high	Top
	Inches	Inches
Hemlock	10	5
White pine	10	5
Spruce	10	5
Balsam	10	5
Paper birch	10	6
Yellow birch	10	8
Black birch	10	8
Beech	10	8
Chestnut	8	5
Red oak	10	8
White oak	10	8
Hard maple	10	8
Red maple	10	8
Silver maple	10	8
Basswood	10	8
White ash	10	6
Cordwood — all species	5	3

Obviously then the first step in planning the estimate of a tract is to find out to what uses the various species can best be put. This is in the main determined by the local industries. Hardwood logs are so heavy that they cannot be hauled long distances. As a consequence it often happens that a tract may have maple admirably suited for flooring but the absence of a planing mill makes it impossible to consider any other use than fuelwood.

Volume tables exist for all the important species in this type — see Graves' "Mensuration" and Hawley and Hawes' "Manual of Forestry." While it may be permissible to use a table based on total height for softwoods, merchantable length is the only safe factor for hardwoods. There are two reasons for this. In the first place there is great variation in the usable lengths of hardwoods on account of the size of the branches. The straight main trunk and small side branches of a conifer are entirely different. With the latter it is entirely possible to get a reasonably close

estimate with a table based on total height and using a general average for the top diameter. But with hardwoods the top diameter may vary 100 per cent or more depending upon size and location of the side limbs. The second reason why usable length is much safer is that hardwoods are more subject to fungus disorders than softwoods especially where ground fires have been frequent or the limbs have been broken off by the wind. This means that a log length or two must be discarded in an otherwise sound tree on account of rot. With a log length table this is possible whereas a total height table does not have the same flexibility.

Summing up, then, the difficulties and favorable factors that are encountered in estimating in this type, the accessibility and easy slopes make for quick work while the small size of the tracts, the varying composition, and the high percentage of defect amongst the hardwoods increase costs. An average of 20 strip acres per day for a crew of two men is good and the cost per acre can seldom be kept below 10 cents. Fifteen cents may be necessary if the tracts are small.

The general principles which determine stumpage prices have been explained in the discussion of the spruce type so that it is only necessary to enumerate the main facts with regard to prices in the hardwood type.

The best collection of average stumpage prices by regions and states is that published by the Forest Service in Bulletin 285, The Northern Hardwood Forest. The most important are reproduced here:

COMPARATIVE STUMPAGE PRICES FROM REPORTS OF SALES

1912

	N. E. States	Lake States	S. E. States
Birch	5.61	4.85	3.33
Beech	4.38	3.67	2.86
Elm			
Hard maple	5.98	4.58	3.45
Basswood	8.40	6.30	4.92
Ash	9.03	5.82	6.16

Altho compiled from records of actual sales kept by the Office of Industrial Investigation they cannot be taken as average figures for the regions referred to because they apply to only the most accessible timber. Inaccessible timber would not be sold. As a whole, then, they are higher than can be expected on the average.

Furthermore there is considerable variation within the groups of states cited. Among the northeastern timbered states New York and Pennsylvania record the highest stumpage, as might naturally be expected from their advanced industrial development. However, Ohio and Indiana have still higher prices but they are essentially agricultural states with very little true forest soil. In the Great Lake region Michigan with its large manufacturing interests shows the highest stumpage prices. For the same reason Maryland leads among the states of the southeast. The following table shows for each of the important hardwood species the maximum and minimum prices recorded in 1912 with the state in which they occur.

MAXIMUM AND MINIMUM STUMPAGE PRICES

1912

Species	Maximum price	Minimum price
	Per M	Per M
Maple	$7.94 Indiana	$2.70 Virginia
Birch	6.14 New York	2.31 Tennessee
Beech	6.15 Ohio	1.83 W. Virginia
Basswood	11.59 Ohio	3.30 N. Carolina
Elm	9.43 Ohio	2.67 Virginia
Ash	15.87 Ohio	3.85 W. Virginia

It is evident that maple commands the best price in the north central states where the nearness to market, small supply, and high quality all combine to increase the stumpage price. Both Ohio and Indiana are primarily agricultural and manufacturing states so that what little timber is left would naturally be valuable and in addition the finest quality of maple grows in deep, agricultural soil such as occurs in these states. Of the northeastern states New York reports the highest prices and Vermont the lowest but there is only a range of $1.72 or 40 per cent. In the

Lake States stumpage prices vary from $9.86 to $3.48 or a difference of $6.38 or 180 per cent. The southern Appalachian states show a variation of $2.61 or 96 per cent with a minimum of $2.70 in Virginia and a maximum of $5.31 in Maryland. These prices are, however, of little value in arriving at a definite notion of the average value of maple stumpage unless accompanied by statistics showing the distribution of the standing timber. For example, while the stumpage prices in Indiana are high there is so little timber that the effect upon the general level is negligible. Frothingham's estimate of the total amount of stumpage shows that the northeastern and Lake States contain 87 per cent of the total stand. As a matter of fact, the hardwood type is relatively unimportant in other parts of the country.

Since these figures are of little value in determining the stumpage price on any particular tract it is necessary to supplement them by logging costs and average selling prices. Average costs of logging were as follows in 1915:

	Per M
Felling	$2.50
Skidding	3.00
Hauling to mill, 3 miles	4.00
Milling	4.00
	13.50

These costs are naturally higher than for softwoods because hardwoods are heavier, crooked and generally more difficult to handle. Even at the sawmill they cost more on account of their hardness. Their proper seasoning is also more difficult since they require closer sticking and more protection from the weather. The softwoods mixed in amongst the hardwoods can be handled for $3.00 to $4.00 per M less. Expressed in man hours and horse hours per M the costs would be as follows:

	Man hours	Horse hours
Felling and bucking	6	
Skidding	5	6
Hauling to mill, 3 miles	10	20
Milling	10	
	31	26

This means that a felling crew of 2 men would have to fell and buck 3M per day, the skidding crew handle as much, and the hauling teams make three trips per day with at least 300 board feet per load.

The logging and milling methods follow very closely those employed in the spruce type. The large camp is the rule because of the greater efficiency secured by having the men close to their work. Skidding on the bare ground is the common practice because the logs must be bunched up before being hauled out on two-sleds. The slopes are seldom steep enough to make it worth while to bobsled the logs directly to the railroad or mill. Hardwood logs cannot be successfully driven. The capacity of the mill varies within wide limits. Many successful operations have large mills with railroad transportation from the woods. This insures the highest efficiency of manufacture because solid foundations are needed if hardwood is to be sawn well. But it does not encourage close utilization in the woods. By reason of the cost of transportation to the mill there is a strong tendency to only haul out the high grade material. To prevent this loss of the lower grades and save on the haul from the woods the experiment has been tried of placing the mill in the woods. Then a higher percentage of the felled tree reaches the mill but only the seasoned product in a more or less finished state is hauled out. If the produce is boards the saving on the haul is considerable since even air seasoned hardwood lumber weighs about half that of the same amount of lumber in log form. An even greater saving can be made where some form of finished product is manufactured. Dowel, handle and bobbin mills, for example, located close to the woods, utilize the tree fairly closely and have merely the finished product to haul.

All the species make excellent firewood since they have a fuel value per cord equivalent to about three-quarters of a ton of coal. Cordwood cost from $1.50 to $2.50 to cut and pile in 1915, or 7 to 10 man hours, and the hauling did not exceed 5c cents per cord per mile.

Average selling prices are difficult to give because of the variety of uses to which the different species are put. The figures

given below are simply general averages which were attained with reasonable care. Higher prices were, of course, secured if special products were manufactured.

AVERAGE SALE VALUES PER M

f.o.b. mill. 1914

White pine	$18.00	Beech	$16.00
Hemlock	17.00	Chestnut	19.00
Spruce	18.00	Red oak	18.00
Balsam	17.00	Hard maple	18.00
Paper birch	17.00	Soft maple	17.00
Yellow birch	17.00	Basswood	18.00
Black birch	17.00	White ash	20.00

Cordwood sold for $3 for softwood and $4 to $6 for hardwood.

To determine what stumpage price may be realized the costs of logging and manufacture must be deducted from these sale values. For the softwoods there should be a margin of $6 to $10 in the lumber with the chance of getting an extra dollar or two per M from the cordwood. With all the hardwoods, except red oak, basswood and white ash, such high returns cannot be expected, so that a margin of $4 to $7 for the lumber and an additional $1 per M from the cordwood is very satisfactory. Oak, basswood and ash have special uses which enhance their stumpage values so that stumpage prices of $10 per M are paid in the territory tributary to the special establishments which need these species.

Land Values.— Here again as with the spruce type the land seldom has any value aside from what will be paid for the timber. Most transactions have not specified any separate valuation for the land but the transfers have simply been on the basis of stumpage values. Hence in order to determine what the soil capacity is for timber production sales of pasture land must be consulted. Our Puritan forefathers in their hunger for land cleared up many hillsides for pasture purposes out of the hardwood type. The modern tendency is to allow such clearings to reforest themselves and holdings of this kind which are neither pasture or timberland may be purchased for from $3 to $15 an acre, depending upon their location. But these figures cannot be taken as representa-

tive for the whole type because they only apply to the most accessible lands.

On the basis of a 100-year rotation with compound interest at 3 per cent and assuming a final yield of 15M board feet per acre hardwood lands show a value of $4 per acre. This yield is conservative because it does not include thinnings. These latter should easily give a margin above possible losses from fire, insects, fungi, etc.

For agricultural purposes this type of soil has a higher value than spruce land because it is deeper, has a higher percentage of loam with less raw humus and the growing season is longer. Reference has already been made to the use of these lands for pasture prior to the Civil War. It is conceivable that a similar demand may recur but it seems more probable that the steepness of the slopes and number and size of the rocks will prevent profitable cultivation. Taken as a whole at least 90 per cent of the type may safely be said to be better adapted to the growing of timber than to either tillage or pasture.

Titles.— The past history of land in the hardwood type makes the searching of titles a difficult problem. The unit areas are small, the surveys are poor and transfers are not recorded accurately or completely. Such a condition of affairs is inevitable with land which has been considered of little value for a long period. The only saving factor is that these so-called "back pastures" and "sugar bushes" have in many cases been regarded as integral parts of the farm and transferred accordingly. It is, however, always necessary to look up the probate and tax sale records to make sure that there are no liens on the property which do not appear in the County Recorder's Office.

CHAPTER III

WHITE PINE TYPE

General Conditions.— This is the type from which the colonists obtained the masts and shipbuilding timber to which Pepys made such feeling reference in his diary —

> "From New England ships come home safe to Falmouth with masts for the King; which is a blessing mighty unexpected, and without which we must have failed the next year."

Here were trained the loggers who have made Maine so famous by their exploits with axe and peevy and in this type they have gone westward thru New York and Pennsylvania to the Lake States as the virgin supplies were exhausted on the Atlantic coast. Its exact boundaries are frequently difficult to delimit where the type merges into the hardwood type but roughly it covers the lower parts of Maine, New Hampshire, Vermont and Massachusetts and the more elevated portions of Connecticut. In New York and the Lake States it is a lowland type but only occurs in the northern parts.

The growing season is distinctly longer than with the two types previously considered. Ordinarily frosts do not occur between May 1 and September 15 so that there is a vegetative period of about five months. Moreover, the temperatures are higher. For the year the mean is 50° F. while during the summer the maximum is 100° F. with an average of 65° F. This means considerably more transpiration and evaporation than with the spruce and hardwood types.

Another factor which decreases the total available moisture is the lessened precipitation. This is mainly the result of lower altitude above sea level. The hardwood and spruce types cover the mountains and hills which intercept the moisture-laden winds from the west. Consequently instead of being over 45

inches as with the other two types it seldom exceeds that figure as a maximum. In fact, the pineries of the Lake States have an average annual precipitation of 30 inches.

There is, however, one factor which tends to conserve the precipitation. That is the comparatively level topography which retards rapid runoff. Generally speaking the pine type is confined to the overwash plains formed by the streams which drained from the retreating ice sheets in the Glacial Age. These are gently sloping sand or gravel beds from which the runoff is slow. But the openness of the oil tends to counteract in part, at least, the lack of slope.

As a consequence the available moisture is so deficient that the predominating species, white pine, red pine, jack pine and pitch pine, are all adapted to sites not abundantly supplied with moisture. Species which cannot endure dry sites are restricted to those within the type which by reason of drainage or soil conditions have more available moisture. Hence, hemlock and hardwoods are only found in this type in deep-soiled, well-watered valleys. Moreover, but few of the deciduous leafed trees characteristic of the hardwood type just described occur in this type. The important ones are white oak, chestnut, cherry or black birch, gray birch and black cherry. Paper and yellow birch, beech and red and white ash occur sparingly on the cooler sites included within the type.

Since the pine type is most abundant on lands which were early sought for agricultural purposes, fire and clearing have had profound effects upon the composition of the type. In addition lumbering has played an important rôle in modifying the original forest conditions. As a consequence there are very few stands left which are representative of the type as the early settlers found it. These virgin stands were either pure pine or pine mixed with hemlock and tolerant hardwoods like sweet birch and beech. The usual course of history after the removal of the virgin stands was more or less repeated burnings. Fire was used intentionally to clean up the land for cultivation or allowed to run unchecked in the logging slash. As a consequence the poorer sandy lands are now covered with a scrubby growth of

pitch pine and scrub oak in New England and jack pine in the Lake States. All three of these species are capable of standing repeated burnings. Pitch pine and jack pine have thick bark which does not burn readily and their cones are also almost fireproof. The scrub oak holds its own thru its ability to sprout after being injured. Fire is, in fact, responsible in most cases for the failure of white pine to replace itself. In places where fire is kept out the pine comes in either in pure stands or in mixture with hardwoods. For example, old pastures within the type are quickly covered with pine "bushes" while the hardwoods are kept in check by grazing if the pasture is still used. This results in practically pure stands of pine. If, on the other hand, the hardwoods are not held in check by grazing they frequently occupy the old fields to the apparent exclusion of pine. This is particularly true with such light seeded, vigorous species as gray birch and aspen. But the pine slowly but surely works its way in under the thinner crowned hardwoods and eventually replaces them because it is longer lived so that the final result is a nearly pure stand of pine again. In fact white and red pine are so well adapted to the climatic and soil conditions in this type that they can be relied upon to take possession of the ground if they are given even half a chance.

The commonest subtypes in this type and their composition by number are as follows:

Pure white pine — over 90 per cent white pine.

White pine and hemlock — 50 per cent white pine and 50 per cent hemlock and hardwoods.

White pine and gray birch — 60 per cent white pine, 40 per cent gray birch.

White pine and oak — 40 per cent white pine, 60 per cent red, white, and black oak.

White pine and pitch pine — 50 per cent white pine and 50 per cent pitch pine.

Besides these subtypes based on composition there are also, of course, subtypes due to various degrees of logging, as, for example, virgin, culled, and cutover stands.

Both the fire hazard and liability are high in this type so that damage from this cause is frequent and severe. Locomotive engines and smokers riding on the railroads, in automobiles, behind horses, or walking for business, pleasure or to hunt are the commonest offenders. Two-thirds of the forest fires are due to these two causes alone. For the other third, fires started to clear land, stationary engines and incendiaries are responsible. The important point to recognize with reference to the fire hazard in this type is that it is so situated that it is brought into direct contact with nearly all the human activities of the states in which it is found. It occupies the low lying land near the seacoast where the railroads form networks of interlacing tracks. Farms surround it and cut it up. As a consequence it has had to suffer from every kind of fire carelessness of which man is capable.

But worst of all is the amount of damage which fire can do. The young stands are completely wiped out because the inflammable tops furnish fuel for even a gentle ground fire. Older stands suffer as badly if there is a wind because the fire leaps from the ground and becomes a crown fire. In both cases the thin bark is usually scorched so that the tree dies. Taking everything into consideration white pine stands are as poor a fire risk as any of our timber wealth. After a fire they must be immediately cut. If allowed to stand the sapwood quickly decays and the loss is often as high as 50 per cent within three years.

In addition to fire white pine stands have recently been threatened with another devastating agency. This is the white pine blister rust, an imported European disease with two hosts, the five needle pines and currants or gooseberries. Unless prompt measures are taken for its suppression it threatens all our five needle pines and there is a chain of them across the continent including such important commercial species as the eastern white pine, the Idaho white pine or silver pine, and the sugar pine of California. It is most serious with small trees. Fortunately the disease can be controlled by the eradication of currant and gooseberry bushes, both wild and cultivated. Prompt action on the part of New Hampshire, Vermont, Massa-

chusetts, Rhode Island and Connecticut will effectually check the disease. As compared with the capital invested in white pine timber and woodworking plants the value of all the cultivated currants is practically negligible. Red pine and pitch pine are subject to a similar native blister rust which has as its alternate host sweet fern, but fortunately this disease is not so virulent as the imported white pine blister rust.

Another fungus which occasionally kills white pine is the bracket fungus, Trametes pini, or red rot. This is a heart rot which enters thru a dead limb and destroys the tree by eating away the heartwood. Sapwood it cannot attack. But the decay of the heartwood leaves the tree without a backbone, so to speak, and the wind tumbles it over. The wood of such a tree is, of course, useless since there is but a shell of sound sapwood around the rotted heartwood. It is, however, usually possible to get one or more sound logs from an infected tree because the fungus commonly enters near the ground and works within a limited area. To prevent the spread of this parasite all infested trees should be removed as quickly as possible.

Another imported pest is the gypsy moth. While the larvæ cannot feed on conifers for the first week after hatching they can and will defoliate white pine, red pine and hemlock if they get started on hardwood. Consequently stands of gray birch and white or red pine offer ideal conditions for its development. All the egg clusters laid on the gray birch have the proper kind of food to give them a good start so that after the first week the larvæ are able to digest coniferous foliage. In the individual woodlot there are two methods of control. By all odds the best way is to cut out the hardwoods because they can usually be made to yield some returns as cordwood at least. Painting the egg clusters in the winter with creosote is effective if thoroly done but the expense is usually prohibitive in large lots. It is difficult and time consuming to climb thru a large oak for example. Such methods, while justified for shade trees, are usually not feasible for woodlots.

White pine is attacked by two forms of plant lice — Chermes — which occasionally become abundant enough to disfigure or even

destroy it. In the woodlot the best control measure is to cut and burn the infested trees.

Another insect which disfigures the white pine is the white pine weevil. It kills the terminal shoot by girdling it. The eggs of this beetle are laid in the upper part of the terminal shoot during the latter part of the summer and the larvæ burrow around underneath the bark the following summer. The large number of deformed trees in nearly every second growth stand of white pine shows that the insect is no new pest but has been attacking white pine for at least a century. Nevertheless, it could be greatly diminished, if not eradicated, by a determined and concerted effort. If the infested shoots are cut and burned before the first of August the weevils are destroyed before the adult form emerges.

The principal insect and fungus enemies of the commercial tree species in this type are listed below:

White pine — gypsy moth, Chermes, weevil, blister rust, and red rot.

Red pine — blister rust.

Hemlock — no serious enemies.

Butternut — no serious enemies.

Shagbark hickory — no serious enemies.

Black birch — gypsy moth, heart rot (Fomes igniarius and fomentarius).

Grey birch — gypsy moth, heart rot (Fomes igniarius and fomentarius).

Beech — gypsy moth, heart rot (Fomes igniarius and fomentarius).

Red and white oak — gypsy moth, browntail moth, heart rot (Fomes igniarius, squamosus, and sulphureus).

Elm — gypsy moth, elm leaf beetle, heart rot (Polyporus squamosus).

More complete data probably exists for the growth in this type than for any other in the United States. On account of their high value white pine stands have been very thoroughly studied in New Hampshire, Vermont, Massachusetts, and Michigan. The best information on the diameter and height growth and yield of the species in this type is summarized below:

GROWTH AND YIELD UNDER NORMAL CONDITIONS

	White pine	Red pine	Hemlock	White ash	Aspen	Red Oak	Bass-wood	Yellow birch	Hard maple	Beech
	Diameter in inches, breast-high.									
25 years	5.2	8.9	2.8	10.3	6.6	5.2	4.3	2.8	1.9	2.0
50 years	10.8	16.6	7.6	17.7	12.7	12.7	8.8	5.8	4.9	4.4
75 years	15.0	21.2	12.0	22.0	18.0	15.3	13.4	11.0	8.4	7.0
100 years	19.8	24.2	16.0	24.0	23.3	16.0	17.6	12.5	11.8	9.6
	Total height in feet.									
25 years	35	68	24	60	48	40	30	27	25	19
50 years	75	91	49	75	75	72	50	45	51	36
75 years	98	97	68	80	85	85	68	60	65	50
100 years	112	101	84	85	89	95	84	74	76	61
	Yield in cubic feet per acre.									
25 years	3500	.....	.....	3100	2000	.....	.....	2000	.....	.....
50 years	8500	.....	.....	6350	4000	.....	.....	4000	.....	.....
75 years	11500	.....	.....	8280	4700	.....	.....	5000	.....	.....
100 years	13000	.....	.....	10000	5000	.....	.....	6000	.....	.....

In diameter and height growth and hence volume accretion, since diameter and height are to two functions of volume, white pine, red pine, white ash, aspen, and red oak are in a class by themselves. All of them will attain a diameter of 18 inches and a total height of over 85 feet in 100 years. Basswood almost reaches this size but falls a little short. Of the hardwoods, beech, birch, and maple, the first is the slowest growing. The other two grow from 25 to 50 per cent faster. Hemlock is usually the slowest growing of all. In yield white pine leads because it is at the same time a fairly rapid grower and will stand much side shading. This is the reason why pure stands of red pine and white ash do not yield more heavily. They are intolerant of shading. Aspen has this same fault and consequently does not produce so much wood per acre in 100 years as do stands of beech, birch, and maple.

Timber Valuation.— In the estimating of white pine lots there are only two factors which tend to reduce the cost. First of all the lots are usually accessible. Suitable living accommodations can often be secured within a few minutes' walk of the work. Secondly, the stands are generally quite uniform in composition and density since they are commonly pure, even aged stands. However, these two favorable factors are offset by the high value of the timber and the small size of the tracts. As a consequence a large percentage has to be estimated. Seldom is it safe to take less than 20 per cent and with small lots all the merchantable timber should be measured. In fact estimating as a skilled trade has reached its highest development in the white pine region. A cruiser brought up in the Lake States, for example, has been so thoroly grounded in the need for careful work that he can succeed almost anywhere.

Diameter limits will be the same as in the other types discussed. For breast-height eight inches is the smallest merchantable lumber tree in softwoods and ten inches in hardwoods. The top diameters usually taken are four inches for softwood lumber and eight inches for hardwood lumber. Cordwood can be cut from trees four inches in diameter breast-high and run out to two inches in the top end.

The strip method of estimating costs not less than 15 cents an acre where the amount and quality of the timber and its value are reported upon and a topographic map is also constructed. This should give a 30 per cent estimate with an average run of three miles of strip per working day.

Since white pine was one of the first species to become commercially important unusually good figures are available as to the course of stumpage prices. Two such tables are given, the first taken from Compton's "Organization of the Lumber Industry" and the second from the report of the National Conservation Commission.

Sales of northern pine by the State of Minnesota (includes some red pine and spruce)				White pine stumpage prices in Michigan			
	Per M		Per M		Per M		Per M
1880	$1.47	1905	$7.18	1866	$1.00	1890	$5.50
1885	1.73	1910	8.00	1870	2.25	1895	5.25
1890	2.25	1911	8.00	1875	2.50	1900	10.00
1895	2.18	1912	8.00	1880	3.00	1915	15.00
1900	5.17	1913	8.00	1885	5.00		

Both of these show a fairly regular advance in price. In fact white pine is one of the few important American species in which the stumpage price has equalled the cost of growing the timber. White pine can be grown on rotations of 50 to 75 years for a cost of $10 a M and in both cases cited above that figure has been reached. It must, however, be remembered that the stumpage prices given above are for old growth timber which has taken at least 150 years to reach its present size. Nevertheless, the statement is valid that white pine may be profitably grown. A price of $10 per M has been realized for second growth pine in several places in New England, New York, and the Lake States. To show the regional variation in stumpage prices the Forest Service figures collected in 1912 may be cited:

	Per M
Northeastern states	8.44
Lake states	10.39
Southeastern states	3.91

Mill run values have also increased but not in the same ratio as stumpage prices. For example during the period from 1900 to 1907 stumpage prices rose 121 per cent while lumber prices only advanced 53 per cent or from $12.66 to $19.41. At present (1920) the following prices are being paid by retailers in the large markets:

	Per M
Uppers	$200.00
Barn boards	45.00
Boxboards, round edge	35.00

Logging methods vary with the region. In the New England States and to some extent in New York and Pennsylvania white pine is now confined to woodlots. These the owners log in the winter time using their farm teams. This is the particular region of the portable sawmill. The tracts are small but accessible so that the mill can be readily hauled into the timber and labor can be picked up from the nearby farms. Winter time is preferred both because it is easier to find men then and because of the easier hauling on the snow. The average costs of such an operation were as follows in 1914:

	Per M
Felling and bucking	$1.50
Hauling logs to mill	2.00
Milling	2.50
Sticking	1.00
	$7.00

75 to 90 per cent of the output goes into boxboards so that the average price of the lumber at the mill ranged from $14 to $20 depending upon the distance from a box factory. Hence the stumpage price ranged from $6 to $10 per M. To this could often be added $1 to $2 from the sale of cordwood cut from the tops.

In the Lake States and other places where larger bodies of pine are involved the methods are different. The men must be provided for in large camps back long distances from the railroad. Large mills are the rule and this entails either a long haul or a long drive or both. This is the region where the iced road carefully graded and maintained has been most highly developed.

By it the cost of transporting the logs from the woods to the mill or drivable streams has been reduced to the minimum because the size of the load can be increased 10 to 20 times. Average costs for a Lake State operation were as follows in 1914:

	Per M
Felling and bucking	$1.00
Skidding	2.00
Hauling to drivable stream	2.00
Driving	1.00
Milling	3.00
	$9.00

The only step which is cheaper than in the woodlot region is the felling and bucking. The large size of the timber is the factor which decreases the cost. The transport of the logs to the mill is more expensive because the distance is greater and the work is done in two steps instead of merely one as in woodlot work. Instead of using a skoot to haul the logs the Lake State practice is to skid the logs into piles and then put them onto two sleds. Where a railroad and steam skidders are employed costs can be reduced if the size of the operation justifies the original outlay for equipment. Sawing charges are likewise higher for the large mill than for the portable but the former turns out higher grade material so that its use is justified where the timber is of medium to large size. In fact the returns in the Lake States are usually larger because a greater amount of higher grade timber is obtained. As against an average mill run price of $18 per M for the portable mill the large mill obtained in 1914 $25 per M for its output. Hence, stumpage prices are higher in the Lake States. In fact there is very little virgin white pine no matter how inaccessible that can be purchased nowadays for less than $10 per M.

The amount of work turned out per day also varies in the two regions. In the woodlot area a crew of two men should fell and buck 5M board feet on the average while a day's work with the larger pine is 8M feet. Expressed in terms of man hours it takes $3\frac{1}{2}$ hours per M in the small pine of the woodlot region and only $2\frac{1}{4}$ hours in the stands of old growth timber. Getting the logs to the mill is naturally much cheaper in the woodlot region.

There it costs three man hours and three team hours per M ($\frac{1}{2}$ mile haul) where a small mill is employed. Milling is likewise less expensive, $3\frac{1}{2}$ man hours per M in the portable mill and four in the large one exclusive of planing, dry kilning, etc.

For hemlock stumpage prices there are the data made available in Frothingham's bulletin on the eastern hemlock (Bulletin 152, U. S. Forest Service). They may be summarized as follows:

AVERAGE STUMPAGE VALUES PER M FOOT

	Northeastern States	Lake States	Southern States
	(Estimated)	(Estimated)	(Estimated)
1889	$1.50	$1.00	$1.00
1899	2.75	2.25	2.00
1907	5.72	3.83	2.84
1912	6.28	3.78	3.05

By comparison with the figures for white pine it will be seen that hemlock is from 68 to 28 per cent less than white pine but has increased during the period from 1889 and 1912 between 200 and 300 per cent which is essentially the same rate at which white pine stumpage prices have advanced. In other words while hemlock has fewer uses than white pine, and hence a lower value, its stumpage has kept pace with that of pine but on a lower level.

The logging and manufacture of hemlock differs little in method from that of white pine. It is, however, a heavier and harder wood and does not float so readily. Hence the cost of getting it out of the woods and thru the mill is at least 15 per cent greater. Unfortunately too its sale value as lumber is low because of the rather limited uses to which it can be put. It is generally only used for boxes, framing, and inside finish if carefully selected. Its main competitors are southern yellow pine and Douglas fir, both of which are more durable, and spruce which is easier to work. Consequently its sale value has always been low. At present (1920) the following prices were being paid in the Boston wholesale market:

	Per M
Hemlock frames, 8 inches and under (estimated)	$45.00
Hemlock boards planed and clipped	40.00
Hemlock boards	30.00

Mill run prices would be the weighted average of these figures less the freight haul and handling from the mill to the market. Seldom will they exceed $40 per M.

One factor that increases the possible returns from hemlock lumber is the use of the bark for tanning purposes. This brought from $7 to $11 per ton at the tannery. Yields vary from 2.8 to 0.4 tons per M feet of lumber with an average of ½ ton. Peeling, drying and hauling cost from $4 to $6 per ton.

An additional way in which higher returns per acre may be obtained from hemlock stands is the sale of the tops for pulp. Limbs as small as four inches inside the bark at the top end may be sold for this purpose at from $5 to $15 per cord, unpeeled, where there is a market for it. Cordwood cost from $3 to $6 delivered at the mill and about ½ cord may be obtained from the limbs and tops per M feet of sawlogs.

Summing up the factors which influence the possible returns from hemlock timber, the logging and milling cost from $8 to $10 per M; and the lumber was worth about $16 per M at the mill, leaving a margin of $6 to $8 for stumpage and profit. To this it was possible to add under favorable market conditions $1.50 to $2.50 per M from the sale of bark and $1 per M from pulp-wood. Therefore, the total returns per M should be from $6 to $11.50.

While important locally aspen forms such a small percentage of the total amount of wood used in the United States that separate census stumpage figures have never been given for it. At the present time it sells on the stump for $1 to $5 per cord according to the proximity of plants which use it. Wood pulp for paper and excelsior are the two principal ways in which it is manufactured and for both uses it commands a price of $7 to $9 a cord, peeled. In both industries peeled four-foot bolts are the form in which aspen is usually sold. The minimum top diameter inside the bark is four inches so that it does not pay to cut trees which are less than eight inches in diameter, breast-high. Logging is started about the first of May and must be completed before July 1 to take advantage of the spring peeling season. Two men can fell and peel about 50 trees or 12 cords per day. Sawing into four-

foot lengths and piling takes about twice as long per cord so that the average day's work is six cords for two men. Hence the total cost of the logging was about $1 per cord in 1914 under favorable circumstances but contracts could seldom be let for less than $1.25 per cord and often ran up nearly to $2. The hauling cost varies with the number of turns per day but rarely exceeded 50 cents per mile per cord. The proper stumpage price for any tract may be closely approximated from these costs by deducting them from the sale value. Aspen is sometimes used for lumber where durability is not a factor but it is a soft, weak wood which is difficult to season and did not sell for more than $25 per M retail. As fuel it is excellent where a quick, hot fire is desired but did not sell for more than $4 a cord in four-foot lengths, because there are so many better fuel woods in the northeast. These figures would have to be doubled to bring them to a 1920 status.

The stumpage price of butternut is determined by the value of black walnut for which it is a cheaper substitute. The latter has long held the position of our most valuable tree species, the average stumpage price according to the 1900 Census being $5. Butternut would not bring more than half that price. Both species find their highest use in the furniture trade where mill run butternut commanded a value of $35 per M f.o.b. the woodworking establishment in 1914. Its logging is comparatively expensive because it does not occur in pure stands but scattered here and there on deep soiled fertile spots. Hence the actual cost of getting the logs from the stump to the mill and turning out boards was seldom less than $10 per M. Subtracting this amount plus a margin of $5 per M for freight and miscellaneous charges from the average sale value left a maximum stumpage price of $20 per M.

Hickory is another species which is very valuable to a certain class of woodworkers but which is often left to rot in the woods because of the difficulty of getting it to the user in the form which he demands. Hickory commanded an average stumpage price of $6.69 per M in 1900 in spite of the fact that it is the best handle and spoke material in the world. For the selected boards which

they use the manufacturers paid $50 per M but these had to be at least eight inches wide and free from red heartwood. The weight, hardness and high percentage of defect are responsible for decreasing the stumpage price of this valuable wood. All three factors mean a high cost of logging which is still further increased by the scattered way in which hickory occurs. Consequently it was seldom possible to log and mill hickory for less than $12 per M and even then not more than 50 per cent of what would ordinarily be considered merchantable was put into lumber. Hence the largest stumpage price that can be expected for even accessible timber is $10 per M and the average is under $5.

Some willow and alder occur in this type along the stream courses. Barring the use of the former for willow rods, which is more of an agricultural than forest use, the highest returns can be secured by converting the wood into charcoal for black powder. The wholesale price for charcoal was 50 cents per bushel (1916) and one cord of four-foot wood made 20 bushels of charcoal, the cost of which, including burning, was usually figured at 50 cents per cord. Hence there may be, under favorable circumstances, a margin of over $9 per cord in handling willow and alder charcoal. But, unfortunately, the demand is so localized that there are only a few places where charcoal can be sold. These species are, therefore, seldom reckoned as an asset.

Beech has already been discussed in the hardwood type. Likewise there are only two species of birch which need further elaboration, the gray birch and the black or cherry birch. The former is a small species which is utilized locally. Close to spool or bobbin mills, or a good market for cordwood, it can be sold for $1 to $2 a cord on the stump while four-foot wood at least three inches at the top end inside the bark brought $3 to $5 per cord delivered in 1915. The cost of cutting and stacking was seldom greater than $1.50 if the tops were not piled. Hauling varied with the distance; on a good road a pair of horses should haul a cord without difficulty. Summing up, gray birch is only an asset in the most accessible localities and does not bring more than $3 a cord stumpage even there. It is, however, often a detriment to a tract of white pine because its rapid growth enables it to over-

top the pine and whip off the buds and leaves of the upper branches when there is much wind stirring. Furthermore, a mixed stand of gray birch and pine furnishes ideal conditions for the spread of gypsy moths. Hence it is generally worth while to cut it out of immature pine stands even if the cost of removal exceeds its value as cordwood.

Black birch is an entirely different species. It reaches large size, so that its wood can be used for all purposes to which yellow birch is put, but it also has a special value of its own for furniture. The dark heartwood is most highly esteemed for this purpose and commanded a price of $50 per M at the woodworking establishments in 1914. Its stumpage value is also high, $5, as the Forest Service figures for 1907 show. This is true in spite of the high cost of logging due to the impossibility of finding this species in pure stands.

Yellow birch has already been fully discussed under the hardwood type.

Oak is the only native hardwood which cuts an appreciable figure in the total lumber cut of the United States. It ranks, in fact, third, but even then only makes up 8 per cent of the total. Nevertheless, it is an important group of species for which the stumpage price ranged in 1900 from $1 to $6 with an average of $3 for the United States as a whole. Its main uses are for furniture and cooperage altho it meets a multitude of other demands where strength, beauty and durability are factors. Thirty-eight per cent of all the lumber used in the United States for furniture and fixtures is oak while it furnishes 80 per cent of all the tight barrel staves and a high percentage of the slack staves. Still another important use is for cross ties, 44 per cent of the country's annual output being from this genus alone.

High grade furniture oak, especially that which is to be quartered, has the most stringent specifications. The logs must be of large size, at least 10 inches in diameter inside the bark at the top end, and free from all defects. Plain oak furniture stock is only slightly less perfect. For tight cooperage staves perfect logs must be employed but on account of the short lengths used the utilization can be somewhat closer than for furniture lumber.

Slack staves need not, of course, be made from such valuable trees but still very few defects are allowable. Into railroad ties may be thrown any sound oak which will give a seven-inch face, eight feet long, and be at least six inches thick. This is the standard for a No. 3 railroad tie. No. 1 ties must have a nine-inch face and be seven inches thick and sold for about 75 cents each or about $20 per M in 1915. They are usually worth 100 per cent more than No. 3 ties so that it pays better to put anything but No. 1 and No. 2 tie material into cordwood where oak firewood brings $8 or more per cord.

Oak seldom occurs in pure stands in this type so its logging and manufacture are comparatively expensive from all points of view, hardness, weight, and scattered location of the trees.

Average costs were as follows in 1914:

	Per M
Felling and bucking	$1.50
Skidding	2.00
Hauling	2.00
Milling	3.00
Marketing	1.00
	$9.50

The manufacture of quartered oak cost even more because of the many logs which must be rejected and the extra care needed in sawing. Tie making cost 10 to 15 cents per tie, or $4 to $6 per M, to which must be added the cost of hauling the ties to the railroad. Cordwood cutting could be contracted for $1.50 to $2 per cord or $3 to $4 per M while delivery usually cost about $2 per cord more. Summing up, a tract of oak lumber may bring a stumpage price of $3 to $15 per M to which may be added $4 more, if ties and cordwood can be made out of the tops and small trees.

Elm is an unimportant hardwood which occurs sparingly in this type. Its average stumpage price, $3 per M, 1900 census, is low for accessible timber even tho it can only be employed successfully for certain special uses. It is a fairly hard, fairly heavy wood which is not durable and is most valuable for vehicle stock where its toughness commends it for such purposes as

hubs. It is also somewhat used for boxes and crates and for furniture parts which will not be seen such as drawer backs. All the species are thrown together commercially, but white and rock elm make up 80 per cent of the total cut in the United States. Of these two, rock elm is the tougher but does not reach such large size. An average sale value at the woodworking plant for elm lumber was $30 per M in 1914 but this must be wide, selected stock. The logging and milling are expensive and could seldom be handled for less than $10 per M. Close to centers of population the cordwood in the tops and small trees could be marketed for about $4 per cord so that there was a possibility of increasing the gross yield per tree by that much, there being at least a cord of wood in the limbs and tops to the thousand feet of lumber. Hence the largest possible gross returns that could be expected were $34 per M. From this should be deducted $10 for logging and milling, a variable amount for freight and $2 to $3 for cordwood making and delivering. This left a possible margin for stumpage and profit of about $15 per M. In spite of increased sale values there has been no increase in this margin because operating costs have grown at the same or a greater ratio.

Land Values.— Land values within the white pine type are difficult to determine accurately for two reasons. First, there is the cause already referred to in the spruce and hardwood types, that the land is seldom appraised separately from the timber. This, however, only holds in the case of large tracts like those in northern Michigan. In the woodlot region another reason obtains. There, farms are sold as a whole and it is difficult to separate the values of the tillable land, the buildings and the woodland. Nevertheless, the land has a tangible value which may be closely approximated by using the prices at which pasture is held. Much of this class of land has been allowed to grow up to woods so that it now makes up at least one-third of the present woodlot area in the older sections like New England. Pastures of the rough, stony type which have been allowed to revert to woodland are appraised at $5 to $15 per acre and these figures may be taken as representative of the better kinds of white pine land in the woodlot region.

Productively, too, their value is much the same. On a rotation of 100 years, with interest at 3 per cent, cost of restocking, $10, annual charges, 50 cents, and a final yield of 50M board feet worth $10 per M the land has a productive value of $7 per acre. This is conservative because a yield of 50M per acre should be obtainable without thinning on poor quality soil.

Titles.— The form of lots within the white pine type differs radically in the two main regions where this type occurs. In the woodlot section of New England and New York the lots are parts of the farms and hence may take any shape. Ordinarily, too, they are in small units of 50 acres or less. Hence, the title question is always a difficult one. The lots are difficult to locate on the ground and still more troublesome in tracing claims of titles. Oftentimes it is necessary to purchase a whole farm with its arable land and buildings in order to get undisputed possession to a piece of timber. In the Lake States, however, the situation is entirely different. There the township surveys apply and the subdivision of a property into 40-acre units is comparatively simple. Furthermore, the land has little value for farming and has never been divided into small holdings. The large lumber companies took possession directly from the State or United States and there have been few transfers since. Location and title searching in the Lake States white pine region is an entirely different problem from that which confronts one in the farm woodlot section.

CHAPTER IV

SWAMP TYPE

General Conditions.— This type is a comparatively unimportant one which occurs scattered here and there among the three preceding types. It is all north of Mason and Dixon's line and east of the Great Plains. In other words it is confined to the glaciated regions. In fact the low lying sites in which it occurs are in many cases directly due to glaciation. Beaver dams are also a cause for the poor drainage which leads to the occurrence of this type. On account of the small extent and localized occurrence of this type it is impossible to give its occurrence by states and counties. It is only possible to say in general terms where it may occur.

The climate of the type varies, of course, with the altitude and latitude but in general it may be said that the growing season is shorter than on the surrounding upland because of the poor air drainage. Swamps are more subject to late and early frosts for this reason. While the precipitation is the same as that of the surrounding country the available moisture is greater because of the slow runoff and retarded evaporation. In fact there is too much water in the soil for rapid plant growth.

The height at which water stands has the same effect on root development that a layer of hard pan would have. The roots cannot reach down but must spread out. Furthermore, a frequent cause of swampy conditions is an impervious soil whether it be hard pan or clay. Consequently the soil conditions may safely be said to be very poor for tree growth. Because the roots cannot go down, the tree cannot grow tall and diameter growth is minimized by the short growing seasons.

The species which can endure such untoward conditions are comparatively few. They must be shallow rooted and frost hardy. Arbor vitæ, southern white cedar, tamarack, spruce, balsam, and red maple are the commonest. Usually they occur in more

or less pure stands so that the subtypes are easy to distinguish. The reasons for differences in composition are not always clear. Lumbering, however, usually favors the light seeded species like red maple, spruce and balsam at the expense of the cedars. Consequently, a cedar swamp seldom comes up to cedar again when the poles and posts have been cut out.

In spite of the poor growth conditions insects and fungi ordinarily do very little damage in the swamp type. The most notable exception to this general statement is the damage done to tamarack by the larch sawfly in the early 80's. Nearly all the larger trees were killed over wide areas. Butt rot — Trametes pini and Polyporus schweinitzii — occurs on all the coniferous species found in this type. While fire is very destructive when it does get into the type the wetness of the soil prevents this form of damage except in very dry seasons. But in droughts swamp fires do occasionally occur and are very difficult to extinguish because they burn down into the accumulated duff and peat and may smoulder for days only to break out anew in fresh places.

The unfavorable growth conditions have already been referred to so that it is merely necessary to add that a swamp cannot be expected to produce more than one-half what the spruce and hardwood types will yield in the same time and one-fifth the returns from good white pine soil. This is because the trees are shorter and smaller, not because they do not stand close enough together. Average diameter and height growth figures are as follows:

	Tamarack	Arbor Vitæ	Spruce
	dbh.	dbh.	dbh.
25 years.....	2 inches	1 inch 10 feet	.....
50 years.....	5 inches	2 inches 15 feet	1 inch 7 feet
75 years.....	7 inches	4 inches 23 feet	3 inches 14 feet
100 years.....	8 inches	6 inches 32 feet	4 inches 26 feet

Timber Valuation.— Estimates of this type present only one difficulty, the swampy ground. Hence winter is the best time to work in them. The small size of the type usually necessitates a high percentage estimate but to offset this the stands are usually

uniform in composition and size so that a 20 per cent estimate is commonly accurate enough. The cost should not exceed 15 cents an acre.

The stumpage value of all the swamp tree species has been so low that it is only recently that data has been gathered in regard to them. Cedar is the only species on which the Forest Service has figures. Its stumpage rose from $1.32 to $4.63 between 1900 and 1907, an increase of 250 per cent while the lumber only advanced 75 per cent during the same period, from $10.91 to $19.14. Even these figures cannot be taken as representative of the swamp cedars alone because several western species and the southern red cedar are included under the same name in the Census and Forest Service reports. Hence it is all the more important to present data from which the stumpage value of each individual tract may be worked out.

The most valuable products obtained from the swamps are cedar and tamarack poles, ties and posts. The prices of these on the cars were as follows in 1916:

	Each
Cedar poles	$0.50–$40.00
ties	0.50
posts	0.35
Tamarack poles	0.50– 10.00
ties	0.50
posts	0.30

Spruce and balsam seldom get large enough for more than pulpwood, the specifications and prices for which are discussed in the chapter on the Spruce Type.

Red maple cordwood brought a price of $5 in four-foot lengths in 1915 where the market was good.

The minimum sizes required are as follows:

Poles — 20 feet long and 4 inches in diameter at the top end.
Ties — 8 feet long, 6-inch face and 6 inches thick.
Posts — 8 feet long and 3 inches in diameter at the top end.
Cordwood — 4 feet long and 2 inches in diameter at the small end.

Logging and manufacturing costs in 1916 may be summarized as follows:

	Per lineal foot
Poles — cutting and peeling	$0.02
hauling 10 miles	0.02
Total	$0.04

or $1 for a 25-foot pole.

Ties — cutting, hacking and peeling	$0.10
hauling 5 miles	0.20
Total	$0.30
Posts — cutting	$0.03
hauling 5 miles	0 05
Total	$0.08

Deducting these costs from the sale values given above it is clear that it is possible to have margins for stumpage and profits as follows:

	Each
Poles	$1.00–$3.00
Ties	0.20
Posts	0.22

To put this on a board foot basis it will be necessary to assume certain equivalents. For poles a conservative converting factor is 50 board feet for a 25-foot, 7-inch pole. There are more than 25 board feet in a tie eight feet by six inches by seven inches. A post eight feet by four inches in diameter contains approximately 10 board feet. Hence poles may yield a stumpage price of $10 to $20 per M, ties $5 to $8 and posts $15 to $20. The average figures are, of course, much lower than this on account of long hauls, poor markets, and bad management. No figures of costs in man hours and horse hours exist for this type.

Land Values.— Land values are low for this type because it yields little in timber and needs expensive drainage before it can be made arable. Hence it has little or no value unless it can be drained and turned into celery beds or flooded for cranberry growing.

Titles.— Title problems have already been discussed for the hardwood and white pine types so that no further remarks are necessary for this type since it does not differ from the surrounding upland in title history.

CHAPTER V

SOUTHEASTERN PINE TYPE

General Conditions.— This region lies along the Atlantic seaboard from southern New Jersey to Central Texas. It is made up of low lying, comparatively level sandy lands which seldom rise more than 500 feet above sea level. It is part of what geologists call the Coastal Plain. Between it and the southern bottomlands there is no hard and fast line. The difference between the two is simply one of soil drainage and fertility. With the southern hardwood belt, however, there is a sharper contrast. The pines quickly give place to the hardwoods as the hills of the Piedmont plateau with their stiff clay soil rise from the sandy coastal plain.

The climate is like that of the bottomlands, hot and moist. The winters are short. Scarcely a single month during the year has an average temperature below freezing even in the northern extension of the region. The precipitation is heavy, over 45 inches, and has a distinct period of maximum fall during midsummer. The evaporation is naturally great with the high average temperature. Runoff would also be rapid were it not for the gentle slopes but this is offset in part at least by the openness of the sandy soil. Taking all the factors into consideration the climate may not be said to be especially favorable to tree growth. The evaporation and runoff affect the heavy precipitation so that there is frequently a deficiency of soil moisture. This is reflected in the openness of the stands and the adaptations of the foliage to prevent excessive transpiration.

The topography has already been described in a general way and there is little that needs to be added. It does not present local variations but is remarkably uniform. Extending from the low sand dunes of the coast west to the foothills of the Piedmont Plateau, the Coastal Plain is described by its name. It is a plain without marked elevations or depressions. The soil is likewise remarkably homogeneous in its sandy character altho there is a

tendency for it to have less pure sand on the northern edge of the Coastal Plain where much material has been brought by the streams from the pile of glacial débris to the north.

Fig. 5. Distribution of the Southern Pine Type

might be expected from the climatic and soil conditions the predominating tree species are ones which can stand a relatively small amount of available soil moisture. The longleaf pine was originally the most abundant species but lumbering and fire have

in many places made it second in importance to its more vigorous competitor, loblolly pine (Pinus taeda L.). Shortleaf, pond, Cuban, pitch and scrub pine are also found within this type but seldom in pure stands over large areas like the longleaf and loblolly pines.

In determining the distribution of tne stands lumbering, fire and agriculture are the controlling factors. Virgin timber is almost invariably pure longleaf pine. Areas which have been logged and burnt may be either longleaf or loblolly but usually the latter species is more abundant. Where the land has been cleared for tillage, various species may take possession depending upon the latitude and the degree of soil exhaustion. In the northern part of the Coastal Plain in New Jersey, Delaware and Virginia scrub pine is generally the first invader on abandoned fields with pitch pine occurring only on the poorest portions. From Virginia to South Carolina loblolly pine plays the rôle of soil reclaimer while farther south slash or Cuban pine gives promise of becoming an important source of revenue on worn out lands, and those from which long leaf pine has been cut.

Were fire kept out of the southern pine region the damage would become negligible. Unfortunately, however, there are many reasons why the practice of annual burning has become the rule. First of all there is the argument that the grazing is improved by burning out the old grass every spring. Then, too, the turpentine hackers like to burn in order to discourage the snakes. So potent are these arguments with the natives that the owners of turpentine orchards have adopted the practice of burning around their tapped trees after the inflammable débris has been raked away from the base in order to protect them from fire. Nor can this usage be condemned under present conditions. As long as fires are allowed to burn unchecked it is better to burn lightly annually making provision for the protection of the tapped trees than to allow the débris to accumulate around the bases of the trees to such an extent that the tree is sure to be burnt thru in case of fire.

Freedom from fires will only come as a result of a long campaign of public education. Yet it is easy to show that the small

amount of good done in "improving" the grass and killing snakes is offset many times by the loss in soil fertility, small trees and mature timber. Furthermore, in addition to these direct losses a large amount of indirect damage can be charged to burning because it makes the trees more susceptible to fungus and insect attack.

Annually the red rot fungus — Trametes pini — causes thousands of dollars' worth of damage to living trees. Special care should be taken to see that a tract of timber is not infested with it because it works rapidly and thoroughly.

Another common result of unrestricted burning is a serious infestation of pine bark beetles — Dendroctonus pinicola. This insect, if unchecked, is capable of killing large amounts of otherwise healthy timber as numerous areas in the southeast show.

Other forms of damage are not serious. Snow-break does not occur in the warm climate of the pine belt nor does lightning damage more than an occasional tree. Hurricanes may snap off all the large trees in their path but fortunately they seldom cover large areas.

Stands per acre under virgin conditions, which nearly always means pure stands of longleaf pine, range from 20,000 board feet to 5000 board feet with 10,000 board feet as a high average for large tracts. Second growth stands vary in volume directly with the age so that their possibilities may best be obtained from the following growth figures. Yields per acre in cubic feet may be converted into board feet by multiplying by seven.

OPTIMUM GROWTH

	Diameter		Height		Density		Yield per acre in cubic feet	
	50 years	100 years	50 years	100 years	50 years	100 years	50 years	100 years
	ins.	ins.	deg.	deg.				
Longleaf pine	7	13	65	95	....	....	....	....
Loblolly pine	16	24	85	110	200	100	7125	9000
Slash pine	16	....	85	....	150	....	7500	....
Scrub pine	9	....	63	....	370	....	4650	....

Timber Valuation.—On the whole estimating in southern pine is simple and comparatively inexpensive. A strip estimate covering 15 per cent ought not to cost more than eight cents per acre. This is because the surface is level, the stands are not dense, there are few species, and the trees are generally of about the same size and quality. This uniformity means that only a small percent of the total area need be actually covered in the estimate. Hence large tracts will give good results with a 5 per cent estimate, while a tract has to be less than 30 acres in extent to justify a 50 per cent estimate. In fact the only factor that is liable to cause difficulty in estimating is the boundary lines and even this source of possible error is not present except in one of the original thirteen states. Unfortunately the rectangular system of land surveys was not used by the colonists so that the property lines do not run in a uniform manner but form an intricate maze of lines which is often very difficult to unsnarl. Where such conditions exist the cost of appraising the timber is proportionately more expensive.

The limits of merchantability are commonly uniform because the purposes to which the timber is devoted do not vary greatly from region to region. It is usual to convert the bole into logs up to a top diameter inside the bark of not less than five inches. Of course where there are large limbs to interfere with the clear length there are fewer logs and the top diameter is greater. Tops and limbs may be used for firewood or even pulp where there are favorable market conditions. Rarely there is a demand for the stumps in destructive distillation plants which secure turpentine and its by-products in this way.

The remarks concerning estimating which have gone before apply merely to the estimating of timber for lumber and cordwood. With longleaf and slash pine turpentine is frequently the more important product so that every southern timber cruiser should be able to estimate the number of "cups" or "boxes" that a tract of pine will yield. This is determined by counting the number of cups or boxes which can be placed on a given sample area which is representative of average conditions within the tract. As with ordinary estimating it is better to take this

sample area in the form of a strip rather than in isolated plots because a better average is obtained. The smallest size tree which can be cupped is six inches dbh., but it is far better practice to bleed no trees less than 10 inches. For boxes the tree must be at least 12 inches dbh. because boxing naturally injures the tree more and it must therefore be sturdier to stand up. With both cupping and boxing only one face is possible on trees of the minimum diameters. Those between 18 and 24 inches will stand two faces. Larger trees will stand three or even four faces but care must be taken not to girdle the tree or weaken it so much that it will break off easily. In virgin timber the number of cups or boxes varies from 35 to 50 per acre with an average of 40. Ten thousand five hundred boxes or cups make up a "crop" which includes an area of 200 to 250 acres in virgin timber. Where the timber has been boxed, areas of 500 to 1600 acres are necessary to yield the requisite number of cups for a crop.

For the important species in this type no separate stumpage prices are available. The figures given below are for "southern pine":—

	Per M
1880	$0.05
1890	0.30
1900	0.75
1910	3.00
1920	5.00

These are, of course, merely averages and do not indicate the possible ranges. Generally speaking pine stumpage is more valuable in the north than in the south. Accordingly one may expect to have to pay twice as much for the same grade of timber in North Carolina as in Texas. This is, of course, merely a reflection of the difference in freight rates and the length of haul to the mill.

As far as uses are concerned there is little difference between the different parts of the pine belt. Dimension — house frames, bridge timbers and railway ties — and rough construction lumber take the bulk of the annual cut. Only the clearest and best goes into flooring and finishing lumber. Between species little distinction is made ordinarily, longleaf, slash, shortleaf and lob-

lolly all being sold under the general caption of "southern pine." However, since there is a marked difference in durability great care must be taken to get longleaf and shortleaf where the lumber must be placed in contact with the ground or used for wharfing or piling. It has been necessary to devise a system of grading which will segregate the more durable species. This was accomplished by separating the lumber according to the number of annual rings per inch that appeared on the end of the board or the cross section of the log. The explanation of this apparently arbitrary system of grading is that the less durable species like loblolly pine are much faster growing than the more durable longleaf or shortleaf. Therefore, a board, a plank, or a pile with relatively few rings per inch can be thrown out immediately where durability is a factor.

The prices received at the mill for high grade frames or bridge timbers are not high absolutely, $30 to $40 per M, but relatively a fair value because there is less sawing required than with one-inch boards and no planing. Even flooring or inside finish seldom brings more than $75 per M f.o.b. the mill and it never makes up more than 20 per cent of the scale of the logs sawn up. The tops and mill waste can occasionally be marketed locally for $4.00 to $6 per cord. Hence an average value of $50 per M at the mill is very good indeed.

From this sale value milling and logging costs must be deducted to determine the stumpage value of any particular piece of timber. For running thru the saw mill exclusive of planing, kiln drying and selling $3 to $3.50 per M is a good average figure for large permanent mills equipped to saw high grade lumber. Smaller mills will do it for as low as $2 per M but their average product is usually less well manufactured.

Logging costs vary little thruout the pine belt. The topography is uniform, labor varies little and methods are standardized. The logs are brought from the woods to the railroad with big wheels and then shipped into the mill. Occasionally a portable mill is set up in the timber or a stream is employed for driving but the rule is the large mill fed by its logging railroad. The

following figures are typical of the average operation under the conditions in 1914:

	Per M
Felling and bucking	$0.75
Hauling to railway	3.00
Railway freight	3.00
Milling	4.00
Freight	5.00
	$14.75

Deducting these costs from an average sale value of $25 leaves a margin of $10.25 for stumpage and profit. As a matter of fact prices paid for stumpage are now (1920) between $5 and $10 per M.

Expressed in terms of man and horse hours per M the following figures give an idea of average conditions:

	Man hours	Horse hours
Felling and bucking	2¼	
Skidding and hauling to mill	8	16
Milling	4	—
Total	14¼	16

Land Values. — The problem of setting a proper valuation on southern pine land is difficult because it has in most cases a potential value for agriculture. The climate permits of the raising of a variety of crops and the lands are frequently so accessible to water or rail transportation that they appear susceptible of intensive cultivation. Three factors tend to offset these advantages, however; in the first place, the sterility of pine soil has become a by-word and since there is a large amount of erosion due to the open winter and heavy midsummer rains fertilization is a constant and heavy charge. Furthermore, there is the cost of clearing the land of stumps and the distance to market. Twenty-five to fifty dollars an acre must be figured on to put the land in shape for thoro cultivation. Altho sandy land is well adapted for market gardening if heavily fertilized the distance from market militates against a rapid spread of this industry. Virginia and North Carolina pine lands within a few hours of the Baltimore and Philadelphia markets have been profitably

turned into market gardens but south of there it has only been possible to raise certain special crops like early potatoes from Florida, for example. Of course, market gardens near the larger southern cities have prospered but every section does not contain a New Orleans or an Atlanta.

Probably the best criterion of what the average pine land is worth for agriculture is the standard set at the recent Cut-over Land Conference in New Orleans — April 11 to 13, 1917. There it was agreed that $5 an acre was a reasonable figure for raw lands which had to be cleared, fenced and cultivated. This valuation is not so high that growing a second crop of trees is out of the question. In fact it was resolved that many acres were "better adapted for forest growth than for agricultural crops." Briefly then, while pine land has a potential value for market gardening, general farming and grazing, the economic conditions must be favorable to make these uses more profitable than forestry. For any of these purposes an average value of more than $5 per acre does not seem justified.

Titles. — The same situation with reference to titles prevails as in the rest of the south. In the surveyed parts they are reasonably clear and simple but in the old original thirteen states where the quarter section system of land surveys was not adopted the confusion is almost hopeless. Grants have been issued with reckless disregard to prior claims so that there is a network of conflicting lines. This maze has been still further snarled up by the loss of records during the Civil War. As a consequence a complete abstract of title or even a clear chain of titles is out of the question in many places and it is as difficult to locate grants on the ground. Much of the land has been considered of low value so that no attempt has been made to keep up the fences or corners.

CHAPTER VI

SOUTHERN BOTTOMLANDS

General Conditions. — The Dismal Swamp of Virginia and the Everglades of Florida are symbolic of the dark and mysterious. They have furnished a somber background for many a weird tale. But they are also representative of an important type of timberland which furnishes millions of board feet of cypress and tupelo gum annually. These characteristic species are only found in the wet river bottoms and river swamps of the southeastern United States.

With such a location the climate is mild to subtropical. The growing season is never less than seven months and may be 11 months in duration. The precipitation is usually over 50 inches annually, as a glance at a rainfall map of the United States will show. The south Atlantic coast, the Gulf coast and the lower Mississippi valley are all regions of heavy rainfall. Absolute evaporation figures are lacking but the long growing season would naturally tend to minimize the effect of the heavy precipitation were it not for the great humidity of the swamps. This in turn is mainly the result of the slow runoff. The water from the higher lands accumulates in the low lying river bottoms, converting them into swamps. Hence, it comes about that this type has as much moisture available for tree growth as any in the United States. In fact there is often too much. Tree analyses show that while growth is very rapid on the relatively high river banks the same tree species increase very slowly in the adjacent but wet " back swamps."

Besides cypress and tupelo gum the other commercially important species are cottonwood, red gum, white ash, live oak, holly, mahogany and lignumvitae. Their relative abundance and grouping depend upon two factors, the degree of wetness of the soil and the amount of logging or clearing. In the permanently wet back swamps the cypress and tupelo gum have

proved themselves capable of distancing all competitors in their ability to stand flooding. In fact many individuals of these species stand with their roots permanently in stagnant water.

FIG. 6. Distribution of the Southern Bottomlands

Along the higher river banks there is not the same monotony of composition. The better growth conditions give rise to keener competition. Then, too, there is further complication of clearing for it was along the river banks that the ante-bellum corn-

fields were hewn out of the swamp with cheap slave labor. Altho these clearings were subject to destructive floods about once in three years the heavy yields from the fertile alluvial soil in the two good years tended to offset the loss of the flood year. In these old fields cottonwood and ash usually preëmpted the best drained sites while red gum took the second choice. The latter is, however, far more abundant numerically because its tolerance permits it to grow well in dense, pure stands. Live oak is another species which keeps to relatively high ground if there may be said to be any such thing in a river bottom. Holly, mahogany and lignumvitae are seldom found in abundance but occur scattered sparingly on the better drained portions underneath the other trees. The following subtypes include the principal composition combinations which occur commonly:

Pure cypress.
Cypress and tupelo gum.
Pure red gum.
Mixed white ash and cottonwood.
Hardwood hammock (in southern Florida).

Bottomlands are not favorable places for forest fires so that this kind of damage is at a minimum. Likewise destructive insects and fungi are not abundant, whether because fires have not weakened the timber or because the frequent floods tend to keep them in check has not been yet determined. Beyond a heart rot in cypress — called "peck" — all the bottomland tree species are unusually free from defects.

The rapidity of growth on the better drained sites is truly remarkable. Individually the intolerant species like cottonwood and ash attain the largest diameter and greatest height but in yield per acre the more tolerant red gum and cypress lead. The results of growth investigations of the leading species are summarized below:

ESTIMATED GROWTH IN 100 YEARS

Species	Dbh.	Total height	Yield per acre (3 inches and over dbh.)
	Ins.	Ins.	Cubic feet
Ash	32	120	10,400
Cottonwood	35	150	12,000
Cypress	30	110	.....
Red gum	26	100	.....

Timber Valuation.— The cost of estimating in this type is seldom high, but neither can it be made low. An average figure per acre is eight cents with a range from 5 to 15 cents. The factors which work against low costs are:

Inaccessibility.
Irregularity of boundaries.
Poor living conditions.
Danger from snakes and disease.

Swamp and bottomlands are not frequented by many people. Hence they have few roads. Only the hunter, the hog grazer, the logger, and the moonshiner are called by business, legitimate or otherwise, to penetrate the back swamps and to none is a road a necessity. Even the logger prefers to use water transportation. Unfortunately, however, the estimator cannot do his work well in a boat and must therefore be in the swamp when it is driest and hence least accessible by the usual standards. Bottomlands are governed entirely by topography so that they will not be bounded by any geometric figures of man's devising. This makes the task of determining the area of a tract to be estimated one of great difficulty. Either the outside boundary must be traversed or the estimate strips run close enough together to catch up all the major indentations and excresences. The third factor is really an outgrowth of the first. Where people do not often go for business or pleasure, the living quarters are crude makeshifts only. Hence it is usually difficult to find either a comfortable logging camp or clean farm house to use as headquarters. If tents are used they must be raised above the flood line, protected from roving hogs and cattle, and screened to keep

out dangerous insects and snakes. This type is, in fact, practically the only one in which the danger from snakes is a constant menace. Rattlesnakes occur in other kinds of timber but they are seldom abundant and are not accompanied by the water moccasin, one of our deadliest and most active reptiles. Then too crocodiles occur in the southern parts of the bottomland type.. But probably the most serious enemies of the estimator are the fleas which disturb his sleep, the chiggers which burrow under his skin, the mosquito that inocculates him with malaria and yellow fever, and the bacteria that produce dysentery and typhoid fever. All are abundant in the swamps.

There are, fortunately, certain offsetting factors which tend to keep down the estimating costs. The stands are fairly uniform so that a low percentage estimate is adequate. Rarely is more than 15 per cent necessary. Then, too, the merchantable limits are fairly constant because practically all the lumber cut from the type goes into the general market and the logger does not attempt to utilize below a diameter of 10 inches breast high nor run his logs above a top diameter of eight inches.

Stumpage figures for the species in this type are not abundant but all that could be secured are given below:

	1900
Ash	$3.03 ($2.75 to $3.10)
Cottonwood	1.45 (1.15 to 2.24)
Cypress	1.58
Gum, red	1.68 (1.42 to 1.72)
Gum, tupelo	
Oak, live	3.18 (1.70 to 5.83)

They show that live oak and white ash are the most valuable species while the other three are not sufficiently valuable to get above an average value of $2 per M. It must, however, be understood that the figures given are averages from the whole United States. For the bottomland type they are somewhat too high for the species like ash and oak which occur in other types which are more accessible. The other species which occur only in this type give values which can be taken as representative of conditions in 1900.

To determine the stumpage value of the timber on any particular tract it is necessary to subtract the costs of logging and manufacture plus a reasonable profit from the average sale value. This latter is, of course, determined by the uses of each species and grade. It will, therefore, be necessary to consider in considerable detail what each species can be used for and how much each use will bring.

Ash and oak have already been discussed under the northern hardwood and southern hardwood types so that they need not be taken up again. Cypress is a fairly soft, strong wood with great durability and a handsome figure. Hence, it has a wide variety of uses. It can be used as a substitute for softwoods like white pine and yellow pine especially where a durable wood is required. As a consequence it is in demand for outside construction work, railroad ties and telephone poles. For these purposes it commanded a price varying from $15 to $30 per M at the mill or shipping point in 1914. The higher grades of clear lumber brought even better prices because they can be used for interior finish. Recently cypress wainscoting either stained or "brush treated" to bring out the figure has become very popular so that the best grades sold for $100 at the mill. Equally high prices were paid for the clear lumber used in the consrtuction of tanks, silos, and wooden piping, uses in which the workability and durability of cypress make it preëminent and without competition except from the best grades of white pine and redwood. Even the poorest grades of cypress are ordinarily salable because they can be used for sidewalks and fencing. Hence the average value per M is high and may be summarized as follows in 191

10 per cent at	$100.00	per M	$10.00
20 per cent at	60.00	"	12.00
50 per cent at	40.00	"	20.00
20 per cent at	25.00	"	5.00
			$47.00

Red gum is another wood which started low in the scale of lumber values but has achieved an enviable position. At first it was merely used for boxes and crates and little valued for these

purposes on account of its liability to warp and stain in seasoning. However, as better methods of kiln drying and sticking were developed, it has been more and more used for furniture, gun-stocks, and veneers, uses for which a hard, close grained wood which will take a good polish are needed but where durability is not a factor of importance. The common grades sold for $18 at the mill in 1914 and the high quality at not to exceed $30 per M board feet. The wood has slight value for cordwood so that the tops are usually left in the woods and the slabs and mill refuse are either burned as fuel in the mill boilers or thrown on the refuse heap. Hence, the average value per M feet log scale never exceeded $25 per M.

Tupelo gum is less valuable than red gum because its light color does not permit of its use as a substitute for dark hardwoods like black walnut. In fact it finds its highest use merely as a substitute for yellow poplar or basswood neither of which are used for high grade furniture fronts. However, where handsome figures or durability are not required but softness and elasticity are assets tupelo gum is being employed more and more. The lower grades are usually discarded so that its average value per M log scale was never more than $18 in 1914 and frequently less. Like red gum it is difficult to season.

Cottonwood has about the same uses as tupelo gum: boxes, furniture backs, buggy and sleigh panels, etc. It is equally hard to season, is not hard enough to polish readily, and does not have an attractive figure. Hence its average sale value at the mill was seldom more than $15 per M, nor could the tops be put to any use for fuel or pulp.

Logging methods differ from those employed in any other type because of the water in the swamps. The cheapest way where there is enough of it is to make it an ally and drive the timber out. This necessitates preliminary seasoning even for cypress so that it is a common practice to deaden the trees in advance of logging and allow them to dry out standing. This same method is applied with all the swamp species except ash which floats readily green. Skidding and hauling to a drivable stream may be accomplished in several ways. Where the bottomlands are

dry enough steam railways may be used supplemented by horse skidders or steam skidders. A cheap and effective way is to mount the steam skidder on a flat boat equipped with a steam shovel so that it may dig its own channel. Then the skidded logs are dropped into the cleared waterway behind the scow and floated out to the main stream. The primitive method, but still often employed, is to deaden the timber in the early fall, allow it to season all winter and then float it out during the spring freshets in "roads," so called, which are lanes cut thru the timber during dry weather so that the logs may be floated out. Of course, the main disadvantage of this method is the fact that each step in the operation must wait for suitable weather conditions. Time is money in logging as well as in other industries.

Bottomland lumber operations are most economically conducted in large camps because the swamps are inaccessible from ordinary habitations.

The average costs per M in 1914 for the different steps may be summarized as follows:

	Per M
Deadening	$0.15
Felling and logmaking	0.60
Skidding	3.25
Hauling or driving to mill	1.00
Milling and kilndrying	4.00
	$9.00

A fair day's work for a crew of two men felling and bucking cypress is 7M. Red gum is harder so that 4M per day is normal. Cottonwood, tupelo gum, and ash come in between these two. Hence the cost in man hours would be as follows:

	Man hours per M
Cypress	2¼
Cottonwood	3
Tupelo gum	3
White ash	3
Red gum	4

The cost to the mill likewise varies with the species. Those that float can be transported for eight man hours per M while those that must be hauled five miles will cost about six man hours and

16 horse hours if wagons are used. The milling time ranges from four to ten man hours per M. Red gum is particularly hard to season.

Summarizing the data for the bottomland species gives the following results:

	Costs	Average sale value	Margin for profit and stumpage
Ash	$9.00	$35.00	$24.00
Cottonwood	9.00	15.00	6.00
Cypress	9.00	24.50	15.50
Gum, red	9.00	20.00	11.00
Gum, tupelo	9.00	18.00	9.00
Oak	9.00	25.00	16.00

Land Values.—The soil in this type has a large potential agricultural value if it can be drained and protected from floods. When this can be done it is easily worth $100 an acre for the production of corn, cotton, or truck. But, unfortunately, this involves great expense in nearly every case. A short ditch levee will not answer. The ditches must be miles in length, carefully leveled, and properly interlaced. There is usually only a slight fall and the distribution of this fall over an elaborate network of ditches is an engineering task of no small magnitude. The levees, too, must be conceived and constructed on a large scale. Unless the river is kept within bounds for long stretches the floods will turn the flank of the levees.

Another factor which influences the agricultural value of these lands is the season at which they are liable to be flooded. If the floods come during the early spring the water will subside before the spring planting needs to be undertaken. The damage done can often be repaired. But if the streams rise during midsummer when the corn or cotton is full grown the loss is irreparable. The Mississippi is more liable to early spring floods and summer floods are rare because the periods of high water are commonly due to the melting of the snow at their headwaters. In the Atlantic coast streams the conditions are different. They rise in the southern Appalachians where there is no great accumula-

tion of snow. Hence spring floods are of minor importance. The period of heavy precipitation comes in the summer so that crops planted in the bottomlands of North Carolina, South Carolina, or Georgia are lost about once in every three years. Consequently large drainage schemes are not so practicable in the Atlantic Coast states as in the Mississippi valley where the Federal government has already spent large sums on levees and drainage canals. This difference in the season of flooding is reflected in the prices commonly paid for bottomlands. Lands on the eastern coast seldom bring more than $30 an acre when cleared, whereas the Mississippi lands seldom sell for less than $50 an acre. To determine the value of the bare land the cost of clearing must be deducted. This will be not less than $25 an acre.

For timber productive purposes bottomland is worth $10 an acre assuming a final yield of 100M per acre worth $10 per M, a rotation of 100 years, interest at 3 per cent, cost of regeneration $10 per acre, and 50 cents an acre annually for protection and administration.

In timberland sales the value of the land plays an insignificant rôle in this type as with most other kinds of timberland but it is nevertheless true that bottomlands have as high a potential agricultural value as any type of timberland — if they can be drained.

Titles.— The title problems differ with the method of land subdivision. In all the thirteen original states there is confusion of ownership, a network of overlapping grants, and a multiplicity of claims of titles. Where the state lies wholly or in part within the bounds of the Louisiana or Gadsen Purchase the square section system prevails and there is greater clarity. In both cases, however, the irregularity of the swamp outlines is an obstacle to easy description. Commonly it is necessary to include small parcels of upland in rounding out bottomland holdings.

Still another difficulty in tracing past ownership is due to the destruction of land records during the Civil War. The bottomlands lay in the war zone and many of the old landmarks and records were razed at that time.

CHAPTER VII

SOUTHERN HARDWOODS

General Conditions.— Immediately south of the white pine type a vast body of hardwood timber extends southward along the Appalachian Mountains to Alabama. Westward the plains at the root of the Rocky Mountains are the limit of this hardwood timber. On the north it does not reach farther than southern Connecticut and southern New York as a type but its outposts occupy the warmer sites within the pine type. In the United States it is unique and constitutes our greatest source of hardwood lumber. The only similar bodies of timber are those which occupy the ridges of the lower ranges in France — the Ardennes, the Vosges, the Côte d'Or, the Cevennes, and the Pyrenees — and the Carpathian Mountains in Austria, but none of these possesses the extent, the variety of species, or the rapidity of growth that our hardwood belt does. The accompanying map shows its distribution.

The region is characterized by mild winters, long summers, and medium to heavy precipitation. The growing season ranges from six months — May to October — in the north to seven months in the south — April thru October. The rainfall is heaviest on the southwestern end of the Appalachians in North Carolina where it totals over 65 inches per annum. The lowest precipitation in the type is found on its western edge where grass takes the place of trees. For example in Missouri the rainfall ranges between 34 and 47 inches. As might be expected from the long growing season the evaporation or flyoff is much greater than in the types previously considered. The total amount of moisture available for plant growth is still further reduced by the rapid runoff which takes place on the hillsides. In fact there is probably no place in the United States, with the possible exception of the southwest, where the erosion is so great. Denuded

hillsides are quickly gullied by the heavy summer rains and even during the winter erosion keeps up at a rapid rate because the ground is not protected by snow but is alternately frozen and

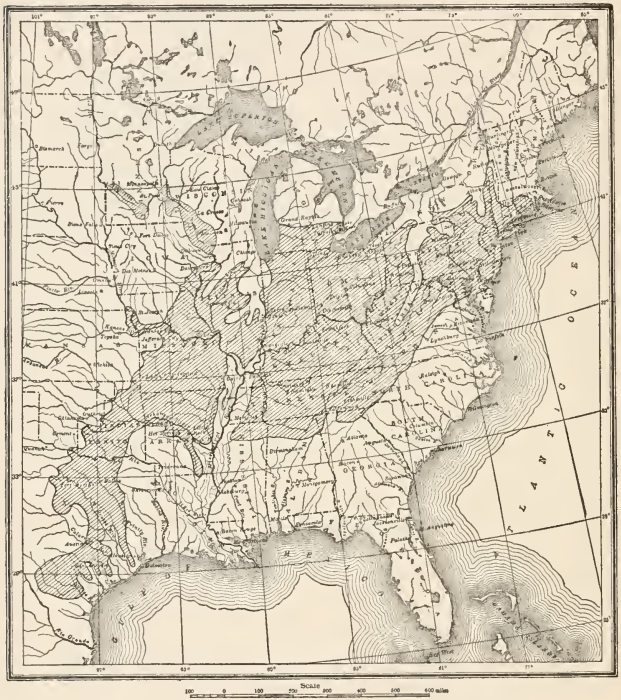

FIG. 7. Distribution of the Southern Hardwood Type

thawed so that the top layer of soil is rapidly broken up and sloughs off down hill.

On account of the rapidity of erosion the characteristic topography of the type is an alternation of sharp ridges and narrow valleys. There are no natural lakes in the southern Appalachians or middle and lower Mississippi valley.

This type has a greater variety of species than any other forest type in the United States because it is the meeting ground of northern and southern species. The cool summers on the mountaintops allow such species as white pine, hemlock, and red oak to extend their range southward while typically southern species like loblolly and shortleaf pine, yellow poplar and cucumber tree have worked their way from the foothills up on the higher elevations. While it is impossible on a small scale map to subdivide the hardwood region, in the examination of any particular tract it soon appears that there are three distinct types with different climatic and soil conditions and consequently a distinct tree composition. The mountain valleys — called coves in the southeast — with deep, rich, alluvial soil, well watered, possess the greatest variety of species. In fact all the kinds of trees would grow here by preference, but yellow poplar, hemlock, the oaks, the hickories, and occasionally the chestnut possess greater reproductive capacity, more rapid growth or greater tolerance, so that they are usually able to crowd out other species. Normally a cove stand which has been untouched by the lumberman's axe is either pure hemlock, pure chestnut, or a mixture of yellow poplar, white oak, cucumber, hickory and hemlock. In this type is found the best timber. It has been the main source of the yellow poplar for which the southeast is so famous. But while it produces large, long boled timber the stands are seldom very heavy. While hemlock coves may occasionally cut better than 30,000 board feet per acre the average for the type is nearer 15,000 feet because the hardwoods do not stand so close together as a tolerant species like hemlock. Unfortunately, also, the total extent of the coves is not great. They seldom occupy more than 15 per cent of a tract and 5 per cent would more nearly represent the mountain conditions. Hence, reports of tracts in the southern Appalachians which average 10,000 board feet to the acre over large areas are always open to serious question. It is the two other types, slope and ridge, which make up the bulk of such tracts and their average stands are much less than that of the cove type.

The slope type is an intermediate one between the cool, moist

climatic conditions of the cove type with its deep alluvial soil and the ridge type which as its name implies occupies the overdrained ridges where the soil is shallow and sterile and evaporation and transpiration are at their maxima on account of exposure to wind and sun. Since, then, the soil of the slope type is not quite so well supplied with moisture as the cove type nor the soil so deep, only the hardier tree species will be found climbing up thru it from the more sheltered coves. On the margin where the two join it is difficult to draw the dividing line by composition alone, but at the upper edge where the slope type merges into the ridge type no yellow poplars, cucumber trees or hemlock are found. Typically its composition by number in virgin stands is as follows:

	Per cent
Oaks	30
Chestnut	20
Yellow poplar	10
Black cherry	5
Hickory	5
Hemlock	5
Other species	15
	100

The average stand per acre under virgin conditions is 5000 board feet. Naturally it is the most extensive type in the southern Appalachians. It usually makes up at least 60 per cent of the total area of a mountain tract.

In the ridge type the number of species is still further reduced. Chestnut and hickory occur sparingly but the important species are chestnut oak and shortleaf pine. The latter preëmpts the southern and western exposures while the chestnut oak is more abundant on the cooler north and east slopes. Seldom do virgin stands average more than 2000 board feet per acre. Fortunately for the productive capacity of the region this type is comparatively limited in area. It usually occupies not more than one-third of a tract.

Fire is here as everywhere the great enemy of the forest. The drier slope and ridge types suffer most. The latter has usually been burnt over at least every other year and frequently annually. As a consequence most of the trees are fire scarred at the

butt and more or less damaged by insects and fungi as a result. Amongst the hardwoods, however, loss from insects and fungi is not serious, probably because there are few pure stands. With pine, on the other hand, which occurs in pure groups, insect damage is frequently very serious, usually after the tree has been weakened by fire. For example, in 1890–1892 the southern pine beetle, Dendroctonus frontalis, killed practically all the mature shortleaf pine and pitch pine in an area extending from North Carolina to southern Pennsylvania and aggregating over 75,000 square miles.[1] Fortunately chestnut blight is the only serious fungus enemy as yet reported from any of the three types altho there are many species which will attack trees which have been weakened by fire.

The growth of individual trees in diameter and height is usually very rapid as the following figures show:

	25 years	50 years	75 years	100 years
Yellow poplar	8″–57°	15″–83°	19″–93°	22″–100°
Chestnut sprouts	8″–50°	13″–77°	17″–88°	20″–93°
Chestnut seedlings	5″–25°	11″–65°	16″–80°	20″–90°
Locust	7″–	12″–	15″–	16″–
Hemlock	5″–35°	11″–64°	16″–82°	20″–98°
Red oak	4″–40°	13″–70°	15″–85°	16″–95°
Black oak	5″–	11″–	14″–	15″–
Red cedar	2″–17°	6″–45°	12″–60°	18″–65°
Shagbark hickory	2″–25°	7″–50°	10″–67°	13″–80°

But in spite of the rapid growth of single trees the yield per acre per annum is not high because the trees do not stand close together. Generally speaking the density per acre is one-half to one-third of that in the types previously considered. This is due to the lack of available moisture. Both the runoff and the flyoff are rapid and hence there is not as much available for tree growth as in the cooler northeast. The low average yields per acre in virgin stands have already been referred to and the yield figures available tell the same story, large trees individually but few per acre.

[1] See reports by Dr. A. D. Hopkins, U. S. Bureau of Entomology.

YIELD PER ACRE — SOUTHERN HARDWOODS

U. S. Forest Service Data

	Quality 1 site, pure, even aged stands			
	25 years	50 years	75 years	100 years
	cubic feet	cubic feet	cubic feet	cubic feet
Scrub pine, Maryland	2510	4650	.....	.....
Yellow poplar, Virginia	3425	5450	.....	.....
Yellow poplar, Tennessee	2000	4000	.....	.....
Hickory	75	500	925	1300
Red cedar	.....	1500	2400	.....

These figures are unsatisfactory at best because they do not differentiate between the types, cove, slope and ridge. Unfortunately, there are no really satisfactory yield data in existence. However, as a guess, using the meagre information available, the average annual growth conditions in even aged stands is estimated to be:

	Cubic feet
Cove	50
Slope	30
Ridge	10

Or in other words it is unreasonable to expect in a rotation of 100 years more than the following amounts unless the stands are thinned intensively:

	Cubic feet	Board feet
Cove	5000	30,000
Slope	3000	18,000
Ridge	1000	6,000

And even these figures could not be realized unless there was complete stocking and thoro fire protection.

Timber Valuation.— It is difficult to generalize in regard to the methods of estimating. There are so many variable factors. In the first place the size of the tracts differs greatly in the different regions. In the southern Appalachians they tend to be large because there are few farms to cut them up, but even there there is no uniformity. The grant system of selling land has led to the setting aside of small holdings of less than 100 years in between

the boundaries of the larger tracts. In the Ohio and upper Mississippi valleys the holdings are commonly small since they are merely portions of farms which could not be tilled to advantage. Obviously a larger per cent of a small tract must be estimated than of a large tract.

Another complicating factor is the variation between types. This has already been referred to. Fortunately, however, the type which contains the most timber, the cove type, is the most accessible while the scantily timbered ridge type is the least so. In estimating, therefore, it is not necessary to take a uniform percentage of the three types but the amounts covered should stand in the ratio of 5 : 3 : 1. In other words, if a 5 per cent estimate is to be made of the ridge type, 15 per cent of the slope type should be covered, and 25 per cent of the cove type.

The third obstacle to be overcome is the variation in merchantable limits. Each species must be investigated locally before it is impossible to say to what size it should be estimated because the diameter limits are determined by the local markets. In general, however, it may be said that lumber should not be estimated below 10 inches dbh. and six inches in the top, cordwood eight inches dbh. and four inches in the top, poles to a top diameter of five inches and posts to three inches at the top end.

The actual costs per acre of estimating southern hardwoods run from 45 cents to 3 cents with an average of 10 cents per acre where the work is done in the usual way, *i.e.*, strips 66 feet wide run out from the base line in cardinal directions so as to cross the topographic features as nearly as possible at right angles.

The Twelfth (1900) Census gives the following figures for average stumpage values for the species in this type:

	Per M
White pine	$3.66
Hemlock	2.56
Shortleaf pine	1.12
Black walnut	5.00
Chestnut	2.71
Oak, white	3.18
Yellow poplar	2.81

These have, of course, no interest at the present time except a historical one and to show relative values.

What the stumpage prices may be on any tract depends upon the cost of logging and manufacture and the average sale value for the lumber f.o.b. the mill. For softwoods, including yellow poplar, the following figures were conservative in 1914:

	Per M
Felling and bucking	$1.00
Skidding	2.00
Hauling to the mill	4.00
Sawing, planing and loading	7.00
Total	$14.00

Hardwoods cost at least $5 more per M because the felling, hauling and sawing are more expensive on account of the greater weight, hardness and crookedness.

In order to determine costs with varying labor prices average costs in man and horse hours per M are given below, separately for hardwoods and softwoods:

	Softwoods		Hardwoods	
	Man Hours	Horse Hours	Man Hours	Horse Hours
Felling and bucking	3	....	6	....
Skidding and hauling to mill (5 miles)	6	16	10	25
Milling	4	....	6	....
Totals	13	16	22	25

Since labor makes up 80 to 90 per cent of the total cost of these items it is possible to get a very close approximation of the whole charge from these figures.

The uses to which white pine and hemlock are put have already been discussed. Shortleaf pine, like most softwoods, has a variety of uses. The better grades command a good price as flooring and interior finish, while the poorer grades make excellent common lumber, railroad ties and wood pulp. The prices which material fit for these various uses brought in 1914 were as follows f.o.b. the mill:

Flooring and finish (30 to 35 per cent of the total cut)	$25.00 per M
Common lumber	10.00 per M
Railroad ties	10.00 per M
Wood pulp	5.00 per cord

Black walnut, hickory, chestnut, and oak have already been discussed under the white pine type so it is not necessary to detail here the uses to which they are put and the values received for the various grades.

Yellow poplar is one of our most valuable and widely used woods. On account of its large size, clearness, and softness it is in great demand for interior finishing. For this purpose it commanded a value at the mill of $40 per M in 1914. The lower grades go into boxes, crates, vehicles, etc., in fact everywhere where durability in contact with the ground is not a prerequisite. The average mill run value was $25 per M in 1914. The tops and limbs may be worked up into pulpwood and brought $5 to $9 per long cord at the pulp mills in 1914.

Black cherry has its main use in furniture where it may be used as a substitute for mahogany or in its own name. The wide clear boards demanded for this purpose were worth $45 per M f.o.b. the mill in 1914. Smaller pieces are worked up into handles for small tools.

Locust has a hard, durable yellow wood which takes a high polish. Its most important uses are for insulator pins, railway ties and fence posts. The average value of lumber at the mill did not exceed $25 per M in 1914.

SUMMARY — COSTS AND VALUES
1914

Species	Logging and manufacturing costs	Average sale value	Margin for stumpage price and profit
White pine	$14.00	$25.00	$11.00
Shortleaf pine	14.00	20.00	6.00
Hemlock	14.00	18.00	4.00
Black walnut	20.00	40.00	20.00
Hickory	20.00	25.00	5.00
Chestnut	15.00	20.00	5.00
Oak	20.00	25.00	5.00
Yellow poplar	14.00	30.00	16.00
Black cherry	20.00	35.00	15.00
Locust	20.00	25.00	5.00

Land Values.— Land values are easier to determine for these types than in the previous ones because all except the ridge types have some agricultural value. The coves, in fact, are usually deep soiled and fertile enough for farm land and should be so used if they are sufficiently large and accessible. In other words farming is their highest use if workable farm units can be made from them. This is the case except in the mountains, and practically all the cove type throughout the Mississippi and Ohio valleys is so used. Its value is mainly determined by its accessibility. In a region of railroads and good roads $200 an acre is not excessive while uncleared stump land of the same quality and having the same climate but inaccessible may not sell for more than $10 per acre. For timber productive purposes it is worth between $5 and $10 per acre.

The slope type naturally has a lower value because it will yield less. Hence, more than $5 per acre cannot profitably be paid for it for forest purposes under present market conditions. It is generally too steep for farming but can be used for pasture in limestone regions. Other types of soil wash so badly that a grass cover cannot be maintained.

The ridge type is likewise usable for grazing but only limestone soils will make permanent pastures. For timber production the value is less than $1 per acre because of the excessive washing and drainage.

Taking the three types together the land has practically no present value. Sales of large tracts of mountain land including the three types have never taken into account the land values but have been based entirely on the amount and quality of the timber until the Forest Service began buying land in the southern Appalachians. The Government has used the following figures:

	Per acre
Cove type	$5.00
Slope type	3.00
Ridge type	1.00

CHAPTER VIII

PINON AND JUNIPER

General Conditions. Location and Extent.— This is the type of woodland which occurs on the foothills of the Rocky Mountains in western Texas, New Mexico, Arizona, Colorado, Utah, Nevada, California, Idaho and Oregon. Above it lies the western yellow pine and below it stretches the plains country with its sparse vegetation of sage brush and buffalo grass.

The climate of the type may be characterized as a hot, dry one, but as might be expected in a type with such a wide range there is a considerable local variation. The mean annual temperature, for example, ranges from 65 degrees to 45 degrees. With the annual precipitation there is less variation. It is quite uniformly 10 to 15 inches. But again, the length of growing season differs greatly from north to south. In New Mexico five to six months are free from frost whereas barely four months have mean annual temperatures above 32 degrees in the northern part of the types range.

The topography and soil are varied and do not seem to have any controlling influence on the distribution of the type. Generally, however, it occupies a well drained slope with a deep loamy soil but the type is found on shallow soiled hillsides provided the climatic conditions are right.

The two species which give their names to the type are the only arborescent forms which occur in any abundance. The pinon, Pinus edulis, is not more abundant numerically but the larger size which it attains and the edible character of its seeds makes it the more important commercially. The junipers, Juniperus, are often more numerous individually but their small size makes them less valuable for firewood and hence they are the subordinate species. A striking feature of the type is the openness of the stands. The trees are scattered with open places in between

which are covered with grass if fertile and moist enough but bare if dry and sandy. Since the trees are seldom large enough to make saw timber an idea of the total volume can not well be expressed in board feet. The cubic foot is the usual unit of measurement. The stand per acre seldom exceeds two cords and an average for the type thruout its range would be nearer one cord.

The growth is relatively slow on account of the dryness of the climate. For yield prediction there is little foundation. The type has had so little commercial value that its growth has not been investigated. It is only possible to say that the average growth per acre per annum does not exceed one-quarter cord.

Even this small annual accretion may be retarded by such parasites as mistletoe and the cedar apple. No especially destructive insects have been reported as yet from this type.

Timber Values.— The only wood products that the type furnishes are fence posts and fuel. These may be cut as small as an inch at the top end and three feet long. The cost of cutting is relatively high on account of the scantiness of the stand but labor is cheap so that $2 a cord is usually ample. Delivering is done in great part by burros, the wood being bound on pack saddles. This costs about 50 cents per mile per cord on account of the expense in handling the many small pieces into which fuelwood has to be cut to allow it to be packed readily on the burros. As a consequence the total delivered value is in the neighborhood of $5 per cord. This leaves a stumpage value of about $1 per cord for the owner of the standing trees.

Land Values.— From the figures given above it follows that the pinon-juniper type has a negative value for the production of wood alone. It is only where the tree growth has additional usefulness as a protective covering to prevent erosion and hinder rapid runoff that the trees can profitably be retained. This use is difficult to measure but it is a real one as the many instances where water is conserved in this way for domestic and irrigation purposes show. The absolute value depends upon the demand but $1 per acre may safely be set as a minimum. An equitable way to determine the value in a specific case would be to deduct

from the sale value all costs of construction, as, for example, the masonry work in a retaining dam, and assign the remainder as the conservation value of the growth on the watershed. To make this more concrete assume the case of a town that gets its water supply from a valley in the pinon-juniper type. The capitalized value of the annual water rentals in the town amount to $5000. The cost of constructing a dam including all necessary roads, interest charges, etc., and the capitalized value of the annual costs of operation and maintenance total $4500. This leaves a balance of $500 for the conservation value of the watershed, or $2 per acre if there are 250 acres.

Titles.— Titles present no special difficulties because this type usually occurs on land that has been surveyed. This means that the boundaries are easy to locate and that transfers have been accurately described by quarter sections. Smaller areas have not usually been sold because the land has so small a value per acre. Its main use is for grazing and at least 40 acres are needed to keep a cow or horse during the year. Consequently the transfers have commonly been in large blocks for the use of some large cattle or sheep outfit.

CHAPTER IX

CHAPPARAL

General Conditions.— The plant formation in which occur sclerophyllons, dwarf, evergreen shrubs and trees is confined to southern California and southern Arizona. Various species of shrubs are found but the type takes its name of "chapparal" from the dwarf oaks which occur in it. Approximately 10,000,000 acres are included.

The rainfall according to the Weather Bureau records varies from 9.54 inches at San Diego to 21.42 inches at San Luis Obispo. The average is, however, less than 15 inches. 60° F. is the mean annual temperature with a range from 22 degrees to 109 degrees and hence the evaporation is high. As a consequence there is a very small amount of moisture available for plant growth more especially since the rainfall is concentrated during the winter months and runs off rapidly.

The length of the growing season is not determined so much by the number of months during which the thermometer is above freezing but by the period during which there is enough moisture.

Chapparal is confined to the slopes of the mountain ranges which are high enough to be above the arid plains country. This is arid because the mountains intercept the rain bearing clouds from the Pacific Ocean. Even the drought resisting vegetation of the chapparal cannot creep down into these areas of scant rainfall. The type is therefore confined to the lower slopes of the mountains of California and Arizona between elevations of 0 to 8000 feet above sea level. The lower limit is only reached near the Pacific Ocean where the rainfall is relatively abundant. Inland the chapparal has to ascend the mountains to obtain enough soil moisture. As a consequence the topography of the type is characteristically steep and much cut up while the soil is thin.

Plummer's studies show that in southern California the distribution of genera by number is as follows:

	Per cent
Adenostama	39
Quercus	14
Ceanothus	14
Arctostaphylos	10
Cercocarpus	5
Artemisia	4
Other genera	14
	100

Of these only the species of oak (Quercus) attain tree form but even they are much dwarfed and can only be used for fuel and fencing.

As might be supposed from the dry climate growth is very slow. An annual increment of one-fifth of a cord of firewood per acre per annum is the best that may be expected.

Fire is the worst enemy of the type and may burn the roots so deeply that a ground cover will not reëstablish itself for years.

Timber Land and Values.— Since the type furnishes nothing but low grade fuel and fencing the question of stumpage values can be treated briefly. Were better material available the dwarf trees would not even be considered for these purposes but the scarcity of trees in the arid region gives chapparal firewood and fencing an average value of $8 per cord, delivered. The cutting, stacking, seasoning and delivering cost a great deal on account of the scattered condition of the trees and the high price of labor. Hence there is seldom a margin of more than $3 per cord for stumpage and profit. With the average stand of two cords per acre, the stumpage value of the timber never exceeds $5 per acre.

For the conservation of water, however, the chapparal possesses a high value whenever settlement creates a demand for domestic or irrigation supplies. This is the prime use of the Cleveland, Angeles, and Santa Barbara National Forests and without such protection the cities of San Diego, San Bernardino, Los Angeles and Santa Barbara would suffer greatly for lack of water. This value is difficult to appraise accurately but $10 an acre does not seem an excessive figure where the water supply of a large city is in puestion.

Agriculturally the type is valueless except for a limited amount of grazing on account of the arid climate and steep slopes. Goats and sheep can obtain a certain amount of winter grazing but this use seldom creates a land value of more than $10 an acre adjacent to settlements. The greater part of this type which is grazed has been considered too poor for private appropriation and remains in the hands of the Federal Government.

Occasionally these lands are valuable for mineral deposits.

Land Titles.— Titles are seldom difficult to trace because the nearness to settlement and demand for mining have forced the survey of the lands within the type. Holdings are for the most part small.

CHAPTER X

WESTERN YELLOW PINE TYPE

General Conditions.— The timber type in which western yellow pine is the dominant species is found all the way from the Canadian line to the Mexican border. Patches of greater or less extent occur in all the states west of the Great Plains. Large solid bodies do not, however, occur in Nevada.

With such a range the climate of the type must necessarily vary within wide limits. For example, the annual average temperature varies from 45 degrees to 60 degrees while the number of months during which there is no growth on account of cold range from three in southern New Mexico and Arizona to seven in northern Montana. In fact the only climate factor which is fairly uniform is the annual precipitation. This never exceeds 25 inches and has a normal range between 15 and 20 inches. Its distribution is not, however, nearly so regular. In the southwest 44 per cent of the annual precipitation comes in the summer months of June, July and August while in the northwest only 25 per cent falls during the same period. Such a wide range of climatic conditions has naturally resulted in considerable variation in the form of the species. In the warmer and drier parts of its range where the scant rainfall is barely sufficient the cones are small and the seeds encased in thick scales. Where there is more abundant moisture the cones are larger and do not retain the seeds so tenaciously.

The yellow pine type is confined to the foothill region of the Rocky Mountains and hence occurs on the lower slopes of the higher mountains. These are usually alluvial in origin or at least covered with loam, sand or gravel to a good depth. The exact effect of the soil upon western yellow pine has not been definitely determined because it grows thriftily on a variety of soils provided they are well drained. Swampy or alkaline soils

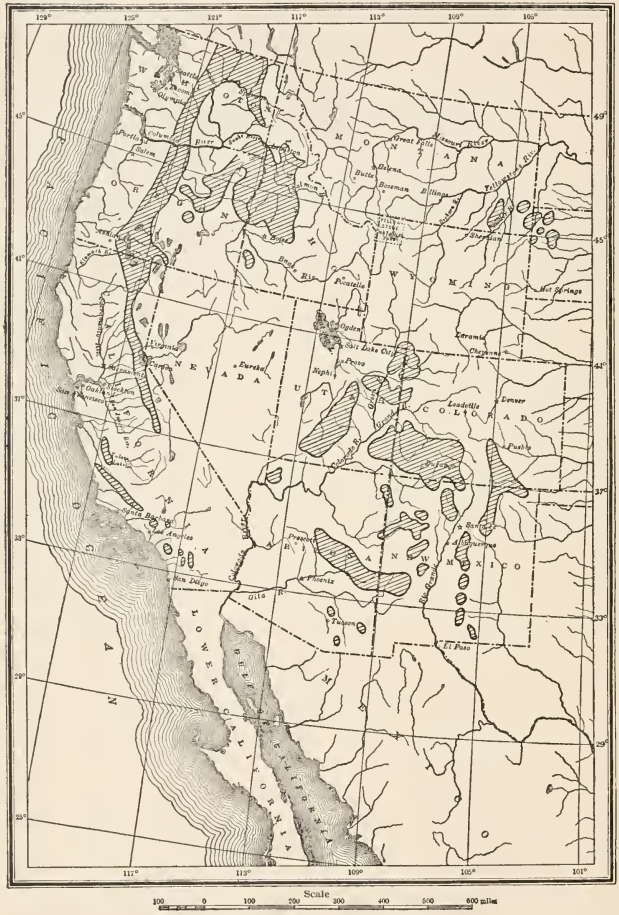

FIG. 8. Distribution of the Western Yellow Pine Type

are apparently unfit. But the soil seems to be secondary in importance to the climate. In other words yellow pine is now occupying the foothill region of the Rocky Mountains not because the soil conditions are particularly favorable but because it has been more successful than any other western species in adapting itself to the climatic conditions which characterize the foothill region.

Western yellow pine is so predominant within the type that the other species which sometimes occur with it may be briefly disposed of. On the lower edge of the type where the foothills run out into the plains pinon and juniper advance a short distance into the type. On the upper edge or on north or east slopes within the type Douglas fir, lodgepole pine, western larch, and Alpine fir sometimes occur but all these species are typical of climates cooler and moister than that of the yellow pine type. Hence for the present purpose the type may be said to be uniformily pure in composition. The other species are never of great commercial importance.

Damage is confined to four main causes, fire, insects, fungi and wind. Of these the most active, the most serious, and yet the easiest prevented is fire. The white man has adopted the Indian's habit of frequent burning so that there is scarcely an acre of the type that has not been burnt over at one time or another. The danger is the more insidious because the apparent damage done is small. The mature trees are thick barked, crown fires are rare and a fire seems to merely burn up old grass and useless litter. But countless young trees are killed in this way, the soil is impoverished and an investigation reported by T. T. Munger in the Proceedings of the Society of American Foresters for April, 1914, shows conclusively that serious harm is done the mature timber. He concludes that, " each surface fire, no matter how light, kills a merchantable tree to each two or three acres, fire scars 42 per cent of the remaining merchantable trees so that they may fall victims to the next high wind or surface fire, and ' pitches ' the butts of a large proportion of the best trees."

But more serious in the long run than this direct damage is the indirect loss thru the trees being weakened by fires so that they

fall an easy prey to insects and fungi. One of the most destructive members of the genus Dedroctonus, or bark beetles, attacks western yellow pine and if the conditions are favorable for its rapid increase damage over a wide area may result. For example in the Black Hills of South Dakota the numbers of this beetle increased so rapidly that practically all the mature timber over an area of 500,000 acres was killed and forced sales were necessary to salvage any of it. The National Forests in California are having a similar experience at the present time. Such infestations get started because the beetles find weakened trees in which they may breed in large enough numbers so that they successfully attack vigorous trees and overcome them by sheer force of numbers. In fact this habit of seeking out weakened individuals where there are but few of the beetles is taken advantage of in combating infestations in the early stages. So called "trap" trees are girdled in the late summer so that the beetles may lay their eggs in them. Then these trap trees are felled, peeled, and the grubs destroyed before the adult beetles can emerge the following spring.

In the same way certain species of fungi, notably red rot, Trametes pini, attack the western yellow pine when trees have been weakened by fire or other causes and spread rapidly unless the surrounding timber is thoroughly sound and healthy.

With the great variety of climatic conditions under which yellow pine grows it is natural that there should be a wide range in rates of growth. The following figures are for growth under favorable natural conditions but do not represent what can be done under intensive management.

GROWTH IN 100 YEARS

	Diameter	Height
	Inches	Degrees
Arizona	14	48
California	20	94
Oregon	13.2	62

Unfortunately no accurate figures can be presented for density and yield per acre in a given time. It is only possible to state

in a general way that from 7500 to 17,500 board feet — 1500 to 3500 cubic feet — has been grown under natural conditions in 100 years. Protection and thinning should, of course, greatly increase these yields.

Timber Values.— The cost of estimating stands of yellow pine should be relatively low because the topography is not rough, the stands are of a uniform density and size, and the Government section — a square mile — is the standard unit of subdivision. Hence, the cost per acre for an estimate which shows the amount and quality of the timber, the topography and the cost of logging should not exceed 5 cents for a 10 per cent estimate. The only feature that is liable to increase this cost is the presence of box canyons which must be crossed. This is always time consuming and sometimes dangerous.

A 10 per cent estimate is usually intensive enough because of the uniformity in the stands and the present relatively low value of the timber.

The smallest merchantable tree at the present time is one with a top diameter of 10 inches while logs can seldom be run higher than to a diameter of six inches in the tops.

The average stumpage value of western yellow pine according to the 12th Census was slightly over $1 per M. This was 20 years ago and prices have of course risen in the meantime but the fact remains that this tree does not yield a large per cent of high grade finishing lumber. It is mostly used for framing and rough construction so that while it is true that about 15 per cent of it on the average brought $30 to $40 f.o.b. the mill in 1916, the mill run sold for not more than $20 per M. Only rarely can the slabs, edgings and tops be disposed of to advantage for cordwood. The average grades, the per cent of each and the price they bring at mill are given in the table shown on p. 92, compiled from data in Munger's "Western Yellow Pine in Oregon," Bulletin 418, Department of Agriculture.

The possibility of using this species for turpentine deserves mention at least. It was so used in California during the Civil War when the southeastern supply was cut off and can be utilized again but so far it has not been possible to compete with the

Grades	Per cent of total cut	F.O.B. value
B and better	6	$35.00
C select	7	30.00
D select	5	20.00
No. 1 shop	10	25.00
No. 2 shop	16	16.00
No. 3 shop	7	11.00
No. 1 common	8	21.00
No. 2 common	16	14.00
No. 3 common	20	11.00
No. 4 common	5	8.00
	100	

southeast under normal conditions by reason of the cheap negro labor obtainable in working long leaf pine. Hence, the turpentine value need not be reckoned in calculating the stumpage price of the average tract.

The normal method of utilizing western yellow pine is to fell and buck the trees into logs 16 feet long, bunch the logs, use four-wheeled truck or big wheels to get them to the railroad and then freight them to the mill. Portable mills have not been used to any great extent because the difficulty in getting water in suitable quantities has made it better to locate a large mill in a central place. Then too such a mill is better equipped to turn out the higher grades. This is an advantage since the local market will not absorb readily the total annual cut and much of it must be shipped to such middle western markets as Kansas City, St. Louis and Minneapolis. Average costs in 1914 were as follows:

Felling and bucking	$1.00
Skidding and hauling to railway	4.00
Freight to mill, 15 miles	1.00
Milling	5.00
	$11.00

There is, therefore, a possible margin of $9.75 for stumpage and profit if an average sale value of $20 can be secured. No account need be taken of possible returns from cordwood because

this is too uncertain. As a matter of fact stumpage prices range all the way from $1 to $6 per M with $3 a high average.

Expressed in terms of man hours and horse hours per M the costs of an average operation would be as follows:

	Man hours	Horse hours
Felling and bucking	2	
To mill	7	15
Milling	4	
	13	15

Railway hauling is only about half labor costs so that man hours are of little value for it.

Land Values.— Besides its value for the production of timber yellow pine land can frequently be used for agriculture. For this purpose, however, it cannot have more than a 5 per cent slope because otherwise it cannot be irrigated and will not " dry farm " well by reason of the rapid drainage. But if fairly level the land can be used for any crop suited to the climate. In fact much of the homesteading in the foothills of the Rockies has been done in this type and very good results obtained where there was opportunity to irrigate. The cost of clearing the land for cultivation is not excessive because there are relatively few stumps. Fifty dollars an acre ought to clear and fence such land and the net annual returns should total $5, so that its productive value at 3 per cent would be over $100.

As a private investment the growing of yellow pine is not attractive. Even with a stand of 15,000 board feet in 100 years and interest at 3 per cent a reasonable return cannot be secured. Where other considerations enter, however, the returns are well worth while. For example, the National Forests yield not only timber but watershed protection for the irrigation interests and support annually a large number of cattle and sheep. Hence from the public point of view the highest use to which any of the yellow pine land not fit and needed for tillage can be put is the raising of timber as the main crop. It would therefore appear that land of this type should not be cleaned for tillage unless it can be irrigated or dry farmed. The tendency has been to clear up more land than can be properly farmed.

While grazing does not bring large returns in itself — 5 to 10 cents per acre per annum — it deserves consideration as a secondary source of income since it can be practiced in connection with forestry. After suitable reproduction has been secured cattle and horses will do little damage to the young trees, and even sheep may be allowed to graze the area as soon as the trees get more than 10 feet high.

Titles.— Land disputes are rare within this type because the boundary lines are plainly marked and there have not been many changes of title since the Federal Government issued patent. For land of level or gently rolling character the mile square section system of subdivision is ideal. Furthermore there has been little excuse for slipshod work in surveying so that yellow pine land is generally well marked and accurately subdivided. Likewise the record of transfers is generally free from the confusion that is found in the archives of the counties which have been settled for 50 years or more.

CHAPTER XI

LODGEPOLE PINE TYPE

General Conditions.—This type occurs in the higher mountains — at least 4000 feet above sea level — of Colorado, Utah, Wyoming, Idaho and Montana. Altitudinally it is the next important timber type above the western yellow pine and reaches nearly to tree line on some of the lower and more protected mountains. Generally, however, it gives place to Engelmann spruce and alpine fir before tree line is reached.

Since it occurs at a relatively high altitude the precipitation is naturally greater than in the yellow pine type. Exact figures are not available but it seems safe to estimate that the annual precipitation averages between 25 and 35 inches. The mean annual temperature is low, 40 degrees to 45 degrees, as might be surmised from the altitude. Likewise a high percentage of the year has temperatures below freezing. In fact the growing season does not exceed five months.

From the previous description it follows that the topography is generally steep and rough. Lodgepole pine does, however, need a fair degree of soil depth so that it is never found in abundance on ledges or rock cliffs.

Usually no other species is vigorous enough to contest successfully with lodgepole pine for the possession of soil adapted to the latter. It is a prolific seeder, a thrifty grower and has few enemies. Hence it usually occurs in pure stands over large areas. Only occasionally are there small groups of aspen, Douglas fir, alpine fir, white bark pine or western larch mixed with it.

While there is great range in the growth conditions the following figures give a fair notion of what lodgepole pine can do under good conditions in 50 and 100 years.

	50 years	100 years
Diameter	7.5 inches	9 inches
Height	46 feet	68 feet
Density per acre	1250	600
Yield per acre	2250 cubic feet	10,800 board feet

FIG. 9. Distribution of the Lodgepole Pine and Engelmann Spruce Types

Timber Values. — The roughness of the topography is the only factor that makes estimating in the lodgepole pine type expensive. The stands are uniform in size and density and the section corners are easy to find. Therefore, a cost of five cents per acre for a 10 per cent estimate is representative of average conditions.

Lodgepole pine is not quoted separately in the census figures because it is only of importance locally, but the stumpage price for any particular tract can be figured by deducting the cost of logging and milling from the sale value of the finished product. On account of its small size — very few trees attain a diameter breast-high of more than 14 inches — relatively little lodgepole pine is sawn. Most of it is used in the round as mining timbers, fencing or hewn railroad ties. Moreover, the little that does go thru the sawmill makes narrow, low grade lumber which sells for less than $30 per M at the mill. The market for slabs and edgings is neglible and the tops are so small that little cordwood can be cut from them, so that no return can be expected except that to be obtained from the main bote.

Since a tie operation is more typical than a lumbering job figures will be given for the former in order to show what the cost of getting lodgepole timber in shape for market is under normal conditions.

	Per tie
Felling, hacking and peeling	15 cents
Hauling four miles to railway	15 "
Total cost	30 "
Value at railway	40 "
Margin for stumpage and profit	10 "

To convert this margin per tie to the basis of M feet it is necessary to multiply by 30 since the average tie contains $33\frac{1}{3}$ board feet. Hence the margin per M is $3.33. Actual stumpage prices range from $1 to $5 per M with an average of not more than $3. Even this is relatively high for such small sized lumber but lodgepole pine occurs in a region where large timber is scarce and the settlers are glad to get almost anything in the way of wood.

In man hours and horse hours the average costs per M will be as follows:

	Man hours	Horse hours
Felling and bucking	4	
To mill	7	15
Milling	4	
	15	15

Land Values.— Most lodgepole land is too rough to be tilled so that its main value is for the production of timber. For this purpose alone it will not pay a profit but a combination of timber raising, grazing and watershed protection does yield well.

Where the land is not too rough and steep to till and irrigate it commands the same prices as raw yellow pine land, $5 to $10 per acre, and has the same productive capacity.

For grazing it is not so valuable because the shade of lodgepole pine stands does not permit the more valuable grasses to thrive. Hence, only so called " weeds " are found in this type and they are not palatable except to sheep. Five acres are needed to keep a full grown ewe or wether during the summer which means a value of about $2 per acre.

Titles.— Titles are in all respects similar to those in the yellow pine type except that the land is less liable to have been surveyed because of its greater inaccessibility.

CHAPTER XII

ENGELMANN SPRUCE TYPE

General Conditions.— Capping the tops of the higher peaks in northern New Mexico, Colorado, Utah and Wyoming are unique stands of timber which in their luxuriance and density remind one of the tree growth of the northeast or northwest. In these Engelmann spruce is the dominant species. Naturally they do not occupy any considerable area because the peaks extend upwards and not outwards and they are not much known either commercially or scenically. But no description of Rocky Mountain timber resources would be complete without a reference to this very distinct and locally important type.

On account of the inaccessibility and bleakness of their location no accurate, long time climate records have been kept within this type. It is merely possible to say in a general way that the precipitation is evenly distributed, relatively heavy, at least 35 inches, and that the mean annual temperature is below 35 degrees. Hence it follows that the growing season is short. In fact at least eight months of the year have average temperatures below freezing.

As stated above this type is confined to the higher peaks so that the topography is rough and steep and the soil shallow. Like its eastern relative, the red spruce, Engelmann spruce can cling to mountain sides where the actual mineral soil is not deeper than a few inches.

Normally the stands are nearly pure in this type but on the lower edges on the deeper soiled sites lodgepole pine, Colorado blue spruce, aspen and Douglas fir occur. In the southern part of its range Engelmann spruce is also occasionally associated with bristle cone and limber pine. It loses its capacity to dominate as it approaches the Canadian line. For example in northern Idaho pure stands are very rare and limited in extent but mixtures

in which spruce is found with Douglas fir, lodgepole pine, western larch, silver pine, hemlock and western red cedar are not uncommon. The only other species that has the same tolerance for the thin soil and high wind of the mountain summits as Engelmann spruce is alpine fir, but it is seldom more than a subordinate associate. The merchantable contents vary from 3000 to 50,000 feet with an average of 5000 feet per acre.

As might be expected from the rigorous climate and thin soil growth is slow. The following figures show what 100 years will give under average conditions:

Diameter	6.2 inches
Height	60 feet

Timber Values.— The cost of estimating is neither cheap nor very expensive. Five cents an acre should give a 10 per cent estimate. The factors that make for cheapness are uniformity of stand and size of timber while the rugged topography and relative inaccessibility increase the cost. Inaccessibility has two phases which may both be of importance. In the first place the Engelmann spruce type is usually a long distance from roads and hence transportation is slow, difficult and costly. Secondly, the fact that the type is hard to reach reduces the probability of its having been surveyed. The Land Office has naturally concentrated on the more accessible public land in the foothills which was in demand for tillage and grazing as well as for the timber. Furthermore, even when surveys have been made they are likely to be poor in quality. The contract method of surveying is not conducive to accurate work under difficulties because the surveyor's main object is to cover the largest possible area at the minimum cost. In addition the inspection of mountain survey work has been notoriously lax. The temptation to hurry over the inaccessible mountain peaks is very strong and only the most conscientious inspectors have resisted the impulse to be lenient with contract work in such localities. This failing of inspectors has been taken advantage of to the fullest by the contract surveyors.

The following minimum diameter limits are used in estimating timber within this type:

Species	Diameter breast-high.	Top diameter
	Inches	Inches
Engelmann spruce	10	5
Alpine fir	10	5
Lodgepole pine	8	4
Douglas fir	10	5
Aspen	8	3

Lodgepole pine is cut to a smaller size because its taper is less abrupt than the other species. Aspen may be cut to eight inches in diameter breast-high since it is the best firewood to be had in the southern Rocky Mountains and much sought for this purpose. It is the only species that should be estimated in cords.

None of the species in this type are listed separately in the Census because they are of only minor commercial importance as they grow in the type. This does not mean that Douglas fir, for example, is not an important timber tree but only that the individuals which are found in this type do not reach the general market. When used at all they are employed for local purposes only. Hence there do not exist any figures which show the variation in stumpage prices for the species found in this type in different states and in various years. It is only possible to say in a general way that no stumpage in this type is worth more than $5 per M. The values applicable to individual tracts must be figured out on the basis of average sale values and logging and manufacturing costs.

Generally speaking logging costs are high because of the inaccessibility and small size of the timber. Its density and uniformity of diameter and height are the only factors that help to decrease the cost. Inaccessibility means high cost of supplies and labor and small timber is more expensive to buck, haul and saw, the main items of logging and manufacturing cost. The following figures are averages based on the methods commonly employed in this type and representative of conditions in 1915:—

	Per M
Felling and bucking	$1.50
Skidding	2.00
Sawing	4.00
	$7.50

Portable mills are the rule and they are placed as near the timber as possible. This is why the cost of getting the logs into the mill is low. But this is offset by the distance from market. A mill set up near the head of a timbered gulch may be close to its source of raw material but there is always a long haul to the railroad or the ranches in the valley beneath. Hence the sale value at the mill was seldom more than $15 per M in 1915 for the log run and commonly less. This left a possible margin for stumpage and profit of $8.50. This was the maximum. The average was nearer $5 per M, nor could this be materially increased by the sale of firewood. The tops and slabs will seldom pay for salvaging. Aspen is the only good fire wood in the type.

The costs in man hours and horse hours will average as follows:

	Man hours	Horse hours
Felling and bucking	3	
Skidding to mill	3½	4½
Milling	3½	
	10	4½

No appreciable difference exists in the average sale value per M of the log run of the different species, because they are all used for the same purpose — rough construction. Of course there is variation in the durability and workability of the species for different purposes. For example, no one would use a spruce barn sill if a Douglas fir one could be obtained, but the difference in durability would amount to only a few dollars per M and perhaps be offset by the greater usefulness of spruce for other purposes. The fact remains that nearly all the species found in the Engelmann spruce type can be used interchangeably in the uses for which they are desired provided the sizes are right.

Land Values. — Since tillage is out of the question on Engelmann spruce land it has value only for the production of timber, occasionally for grazing, the protection of water supplies, and for scenery. For the first purpose it is not an attractive investment for the private individual because the rigorous climate inhibits rapid growth and the yields are therefore low in spite of the density of the stands. This very density reduces its value for grazing because grass and herbs do not find sunlight enough for

their growth. Only sheep can find anything to eat in this type. But the density is a favorable factor again when it comes to conserving moisture and spruce stands play an important rôle in this way. They are especially useful because they are commonly located at the heads of the valleys of the streams which furnish the supplies of irrigation water for the valley farms below. Another very important use from the national point of view is their scenic value. No one will deny that much of the beauty of the higher Rocky Mountain peaks is due to the dark green patches of Engelmann spruce clinging to the mountain sides. We are at last beginning to recognize this function as a useful one and insisting that such mountain slopes be protected from reckless denudation. In other words this intangible use has so great a value that the public will not permit cutting in which no provision is made for a second crop and to enforce this mandate has created National Forests and Parks thru Congress. Hence, lands which will not pay dividends for the production of timber alone give handsome returns when the by-product uses, grazing, the prevention of erosion, the protection of water supplies, and recreation are considered. These by-product values the public, thru its agent, the Government, can afford to conserve.

Titles.— No special difficulty need arise under this heading when the lands have been well surveyed. Unfortunately, for reasons explained above, this is sometimes not the case. Hence the location of much of this type is very vague and the chain of title is correspondingly confused. Unsurveyed lands cannot legally be transferred because the title remains in the Government until surveys are made and accepted by the General Land Office.

CHAPTER XIII

SILVER PINE TYPE

General Conditions.—This is a well developed but restricted type confined to northwestern Montana, northern Idaho and northeastern Washington. Even within this area it is not found thruout but merely on the lower slopes of the mountains. It does not reach the upper slopes nor descend into the valleys but occurs abundantly only between elevations of 3000 and 6000 feet above sea level. This does not, of course, mean that the dominant species, silver pine (Pinus monticola,) is not found above or below these elevations. As a matter of fact it descends to sea level at the Straits of Fuca and attains an elevation of 10,000 feet in the Sierras. But the type is not of commercial importance except in the region referred to above.

Climate seems to be the controlling factor in the distribution of this type. In general it is moderately cool and moist. To be specific, the total annual precipitation does not exceed 40 inches, the mean annual temperature is about 45° F., and only five months have average temperatures above 32° F. The type is probably restricted from extending to lower elevations because the precipitation is less in the semi-arid valleys while its upper limit seems to be determined by the length of the growing season.

The topography of the lower slopes upon which the type is found is characteristically gentle. The type does not reach up on to the upper slopes. Hence the soil is deep and alluvial in character being derived mainly from the wash of the slopes above.

While silver pine is the most abundant species and the most important commercially, red cedar (Thuya occidentalis) and hemlock (Tsuga occidentalis) are also found in the type. They always occupy a subordinate position, however. Both are tolerant enough to grow well under the silver pine and mixed stands

FIG. 10. Distribution of the Silver Pine Type

are two storied with the pine always on top. Stands may be divided by their composition into the following groups or subtypes:

	Stands per acre
Pure silver pine.....	100,000 board feet maximum, 30,000 board feet average
Pine and red cedar.....	200,000 board feet maximum, 50,000 board feet average
Pine and hemlock.....	200,000 board feet maximum, 50,000 board feet average

Growth conditions for silver pine on good sites may be summarized as follows:

Age	Diameter	Height	Yield in board feet
	Inches		
50 years.....	7	50	25,000
75 years.....	10	70	40,000
100 years.....	14	100	60,000

These figures are simply estimates since there are unfortunately no accurate measurements for the tree species in this type.

Damage may be either negligible or very severe. Fires, for example, can ordinarily do little harm in the type because the stands are so dense as to keep the ground cover moist except in times of long continued dry weather. But when the woods do dry out a fire that starts on the ground quickly becomes a top fire and kills the entire stand. Hence, the damage is appalling in a serious drought. For example, the fires of 1910 in northern Idaho killed outright thousands of acres of silver pine.

While there are species of insects which attack the silver pine none of them have so far been reported in large numbers. Three fungi, Trametes pini, Polyporus schweinitzii and Fomes annosus have, however, been found to cause a large amount of heart rot. In the Cœur d'Alene region of Idaho investigation showed 7 per cent of the volume of the stand affected by these fungi. These studies by Weir and Hubert (U. S. Dept. of Agr., Bul. 799) covered 1400 trees on seven National Forest sale areas.

Timber Values. — In this type as with eastern white pine the high value of the timber makes an intensive estimate necessary so that the cost is high in spite of the easy topography and uniformity of composition. In fact, nothing less than a 10 per cent

estimate is safe in such valuable timber. As a consequence the costs per acre range from 5 to 10 cents, with the latter as a safer figure if an accurate estimate is to be made. Nor can the relatively level topography, uniformity of the stands in composition, size and density, and the accessibility of the timber offset this single cost factor. This is in brief a problem similar in every way to the estimating of Lake States white pine with the single exception that silver pine is not so near the market and hence not quite so valuable.

The only Census figures available, those for 1900, give low average stumpage values because at the time they were gathered the white pine of the "Central Empire" had not been put on the market in any large amount. The following values obtained at that time:

Silver pine	$1.50 per M
Red cedar	0.77 per M
Hemlock	Not considered merchantable
Larch	Not considered merchantable

At present, however, stumpage values are much higher. This is the natural result of market development. Intrinsically silver pine is as valuable as eastern white pine and can be used for exactly the same purposes. Naturally, however, trade prejudices had to be overcome before a wide market could be found. Furthermore, a relatively low value can only be secured as long as wood is marketed as rough ungraded lumber. High prices are only paid for carefully graded lumber which is especially selected for the particular purpose to which it is to be devoted. The careful grading of silver pine only dates from 1903 while the sash and door mills which now work up the rough lumber into semi-finished form, are no older. Since, however, silver pine is a wood which can be used for pattern work, cabinet making, and fine finishing it is fast commanding the same sale value as eastern white pine. This means that the average value of the mill run at Minnesota transfer was $35 to $40 per M board feet in 1910 based on the following percentages of grades:

Fine finishing lumber	10 per cent at $100 =	$10.00
Sash and door stock	20 per cent at 40 =	8.00
Lower grades	70 per cent at 25 =	17.50
		$35.50

While silver pine competes successfully with eastern white pine, the high stumpage prices which prevail in the Lake States do not hold good for Idaho and Montana. Nor is it reasonable to expect that they should when it is remembered that there is a long freight haul to the eastern markets. This is in fact the main item of cost and averages about $10 per M. To this must be added the usual logging and milling charges so that it is seldom that there is a margin of more than $5 per M for profit and stumpage value. The costs of a typical operation in 1910 may be summarized as follows:

	Per M
Felling and bucking	$1.50
Skidding	2.00
Hauling, 5 miles	5.00
Milling (sawing, planing, seasoning, etc.)	5.50
Marketing	1.50
Freight	10.00
Total costs	$25.00
Average sale value	35.00
Margin for profit and stumpage	10.00

Expressed in man hours and horse hours per M these costs would be:

	Man hours	Horse hours
Felling and bucking	2	
Skidding	3	4
Hauling	9	15
Milling	7	
	21	19

These figures may be safely used in estimating an average "chance" and presuppose the erection of a fair sized mill at some point on the railroad not too far from the timber. Then the logs are either brought in by the railroad, by tractor or by horses. The latter are the most expensive because they suffer severely from the dust. Especially during the summer this frequently gets to be six inches or more deep and only an iron lunged traction engine can keep hauling thru it day after day. At the mill the logs are washed and then put thru the saw, the plane and the dry kiln in order to get out of them the highest percentage of finishing lumber which will show a margin above the

transportation charge to the eastern markets. For the low grade lumber, slabs and edgings there is no market unless the mill itself can use them for fuel. Many plants pay as much as 50 cents per M simply to dispose of them. Consequently the whole profit of the operation must be sought in the lumber which will repay shipment cost.

The three main uses of red cedar are for shingles, poles and piling. For these purposes it commanded the following prices in 1915:

Shingles:

Extra stars, $1.43 per thousand shingles.
Extra clears, $1.71 per thousand shingles.
Approximately, $13 per M board feet f.o.b. the mill.

Poles:

Prices ranged from 55 cents for 20-foot, 4-inch top diameter pole to $33 for an 80-foot, 9-inch diameter pole or from $25 to $60 per M board feet. On account of the higher proportion of small size poles $40 per M is a fair average price f.o.b. the shipping point.

Piling sells for slightly better prices than poles but must generally be straighter and sounder.

The cost of logging shingle material and making the shingles averaged as follows in 1915:

	Per M board feet
Cutting	$2.00
Skidding	1.00
Transportation to mill	2.00
Milling	5.00
	$10.00

Poles and piles costs were as follows:

	Per M board feet
Cutting and peeling	$5.00
Hauling	20.00
Storage, loading, etc.	15.00
	$40.00

Consequently the margins for profit and stumpage were $3 per M in the case of shingles and $5 for poles and piles.

Western hemlock is similar to its eastern relative in properties, so that it can be used for the same purposes. There is not, however, as good a market for it. None of it is of sufficiently high quality to be shipped across the continent so that it is all used locally for dimension lumber and rough boarding. For these purposes it commanded an average price of $14 per M f.o.b. the mills in 1915. Since the logging, milling and other costs amounted to at least $10 there was only a margin of a few dollars for profit and stumpage.

Land Values. — As explained above in discussing the typical soil of the type it is commonly a deep, well drained alluvial loam. This is, of course, first rate agriculturally when the slopes are right for cultivation and in this connection it must be remembered that erosion is not the determining factor with reference to the slope but suitability for irrigation. Obviously steep slopes cannot be irrigated successfully without an expensive system of terraces so that only the level stretches have been sought for tillage. Still another factor has restricted the use of this type for agriculture and that is the cost of clearing the land. With the large number of stumps, frequently over 150 per acre, and the high cost of labor, land can seldom be cleared for tillage for less than $75 per acre. Such a large initial investment demands high returns such as can only be secured by a local market. As a consequence clearing has as a rule been confined to those level pieces of soil which can be cheaply irrigated and which lie close enough to a town to insure an eager demand for the hay, vegetables and fruit raised. In other words, this is not a small grain soil but one where the cost of clearing enforces intensive cultivation. For the same reason grazing is not extensively practised. The natural openings in the woods are few, mainly beaver meadows, and the crown cover is too dense to permit abundant grass or weed growth. Clearing the woods for grazing is, of course, out of the question.

For growing trees this type has a value of at least $5 per acre. The value per acre for grazing is much less than this, $1 per acre,

while the tillage value may be $100 an acre if slope and market conditions are right. Generally speaking, however, the highest use for at least 90 per cent of the type is the production of saw logs.

Land Titles.— Northern Idaho and northwestern Montana are new regions but recently surveyed so that there are few cases in which title cannot be traced directly back to the Federal or State Government. The surveys themselves are for the most part well done because the high quality of the timber, the potential agricultural value of the soil, and the presence of mineral deposits have all conspired to secure good surveys from the General Land Office.

CHAPTER XIV

SUGAR PINE TYPE

General Conditions. — The sugar pine type is one of the illustrations of how favorable the climate on our Pacific Coast is for the growth of trees. It lies immediately above the giant sequoia type on the western slopes of the Sierra and Coast ranges in southern Oregon and northern California and merges on the north into the luxuriant Douglas fir type, the heaviest yielding timber type in the world. In other words, the sugar pine type is that association of trees which has developed the capacity to thrive under conditions which are not moist and warm enough for the sequoias and are too warm for the best growth of Douglas fir.

Commercially the type is of importance from Douglas County, Oregon, to Kern County, California, along the Sierra Range, a distance of 500 miles. In the Coast Range the north and south extent is less, 200 miles from Jackson County in Oregon to Glenn County, California. In an east and west direction the type ranges from 50 miles to 100 miles in width with an average of 60 miles. There is, consequently, roughly 40,000 square miles included within the type. Much of this area is, however, sparsely timbered. Three-fourths of the total stand is concentrated in the mountainous portions of Siskiyou, Trinity and Shasta Counties, California.

Altitudinally the type ranges from 3000 to 9000 feet above sea level but in any particular locality there is seldom a variation of more than 3000 feet. In other words, where the type descends within 3000 feet of the sea as in the northern Sierras it does not ascend beyond 6000 feet while in the southern Sierras the range is from 6000 to 9000 feet.

The climate of the type has certain marked characteristics which differentiate it from that of its neighbors. As stated above the growing season is shorter and the available moisture less than

FIG. 11. Distribution of the Sugar Pine Type

in the sequoia type while the Douglas fir type on the north has a shorter growing season but much more precipitation. To be specific, sugar pine and its associates thrive best with an annual precipitation of at least 40 inches altho they can endure a minimum of 20 inches. Likewise, the largest trees, 10 feet in diameter and 200 feet in height and scaling over 25,000 feet, are only found where the growing season is at least seven months long. Like the rest of California the heat of summer in this type is unrelieved by showers. Fully four-fifths of the precipitation falls during the early spring, late fall and winter.

As was seen in discussing the location and extent of the type it is essentially a mountain form of vegetation. The valleys are too hot and dry to allow tree growth. At the other extreme sugar pine does not reach the summits of the Sierras, at least as a commercial tree, because of the cold. The type may, therefore, be characterized as a middle slope type. From this it naturally follows that the soil is of medium depth because great accumulations of alluvial soil are not found on mountain slopes but still the grades are gradual enough so that the bed rock is covered in most places with a moderate layer of soil. As with other forms of tree growth the chemical composition of the soil has little effect upon the growth of sugar pine and its associates. The physical characters of the soil are the controlling factors, reasonable depth, good drainage and good capillarity.

By composition the type may be divided into two subtypes or cover types, the sugar pine-yellow pine subtype and the sugar pine-fir subtype. The former is the more abundant in the southern part of the type's range since it is an association of trees which are well suited to the hot, dry summers of the middle and southern Sierras. The important species in order of their abundance are as follows:

	Per cent by volume
Sugar pine	25
Western yellow pine	20
White fir	15
Douglas fir	15
Incense cedar	10
Jeffrey pine	10
Sequoias	5
	100

Stands in this subtype range from 60,000 board feet per acre on the moister sites within its range to 2000 board feet on the drier sites with an average of 20,000 board feet.

The sugar pine-fir subtype, on the other hand, is characteristic of the northern part of the type's range and is found where the climate is moist and cool enough for Douglas fir. The average stand per acre is 30,000 board feet with a range from 150,000 board feet to 5000 board feet. The composition by volume is as follows:

	Per cent
Sugar pine	30
Douglas fir	40
White fir	30

This subtype occupies a much smaller area than the sugar pine-yellow pine subtype.

Growth within the type is summarized in the following table:

	Diameter			Height in feet			Yield per acre all species
	1 Sugar pine	2 Yellow pine	3 Incense cedar	1	2	3	
	Inches	Inches	Inches				board feet
25 years	1	4	1	10	15	5	400
50 years	5	8	5	35	45	20	1600
75 years	10	14	8	60	65	35	4000
100 years	18	20	14	92	94	65	7300

These figures are low because they have come from the measurement of virgin timber. Stands under management can be expected to grow much more rapidly because the better species could be aided to dominate the poorer individuals at an early age and thus shorten materially the struggle for supremacy. The yield, particularly, can be much increased. This will come, however, by making the stands more dense so that more trees will grow per acre. Virgin stands have been greatly decimated by fires, insects and fungi but there is no reason why reasonable care may not prevent the greater part of these losses.

Fire is, as always, the main source of damage in this type. On account of the openness of the stand fires do not, however, get off the ground and burn the tops except in rare cases where a long

continued drought is followed by very high wind. As a consequence only the small trees are killed outright but the larger trees are injured at the butt. This is particularly the case on a hillside where leaves, cones and branches collect on the upper side of the tree and form an accumulation of inflammable material that will burn long enough and hard enough to make deep scars. Such damage is not so serious in itself as in its indirect effect in weakening the trees so that they are more susceptible to insect and fungus injury. Similar results follow breakage by lightning, wind, and snow. In such damaged trees bark beetles of the genera Dendroctonus and Buprestidæ reproduce in numbers great enough to attack live timber successfully. Losses of 5 to 10 per cent of the total stand are not uncommon in this way.

While several species of fungi attack the weakened trees in this type no serious damage to sound, living timber has been yet reported. In fact, sugar pine when protected from fire seems unusually resistant to diseases.

Timber Values.— On the whole the advantages offset the disadvantages in estimating in the sugar pine type. The stands are open with comparatively little underbrush. This means few trees per acre with few shrubs and vines to impede the estimator's progress. Then, too, the trees are large size and a few big trees are easier to estimate than the many small trees which it would take to make up the same volume. Another aid is the high proportion of the type which has been surveyed so that tracts may be readily located on the ground. These factors make it possible to get fairly good results from a 10 per cent estimate where areas of more than 100 acres are to be valued. Hence the cost need seldom exceed 10 cents per acre in spite of the inaccessibility of some of the mountain tracts and the fact that the type is usually a mixture of several species.

Separate stumpage prices for the different species in the type were unheard of two decades ago. Private holdings of a size great enough to be lumbered economically were secured by grouping timber and stone claims which were bought at a flat rate of $2.50 per acre from the Government or approximately 15 cents per M board feet. From this minimum there has been

a steady increase until in 1900 accessible sugar pine was worth $1 per M; in 1915 the following prices prevailed in private sales:

	Maximum	Average	Minimum
Sugar pine	$3.00	$2.50	$1.50
Yellow pine	2.50	2.00	1.00
Douglas fir	.....	1.00	.....
White fir	.....	0.75	.....
Incense cedar	.....	0.50	.....

On the National Forests the highest price which has been paid for sugar pine is $3.50 per M feet (1916).

The uses to which sugar pine lumber is put depend upon the distance from the place of manufacture. In California the important industries depending upon this species in whole or part are the box makers, and the manufacturers of sashes, doors, blinds, and general millwork. In the east only the higher grades appear because they alone can stand the freight rate of $8 to $15 per M required to transport lumber to the Mississippi valley and Atlantic seaboard. Hence, east of the Mississippi sugar pine is only in demand for the high grade uses which the native white pine cannot supply more cheaply. It is therefore seldom used for boxes and packing but is generally found in the planing mills and manufacturing establishments that need wide and clear stock. For such purposes it is technically qualified to supplant eastern white pine which has been the standard for two centuries both here and abroad.

In general the wood of sugar pine may be briefly described as moderately hard, heavy, strong and stiff but straight grained and smooth textured. It shrinks, swells and warps very little on exposure to weather but is only fairly durable in contact with the ground. Altho resinous it will not impart undesirable odors or flavors to articles packed in it.

Its sale value at the mill depends upon the quality. Five main use classes are distinguished: thick finish, siding, factory plank or shop common graded for door cuttings, common lumber, and thick common lumber (tank stock and step planks). These

are commonly further subdivided into Nos. 1, 2 and 3 clear, select Nos. 1, 2 and 3 shop, Nos. 1, 2, 3, common, and box. The percentages of the various grades in the mill run vary greatly with the stands. In general the larger trees are found in the southern part of the type's range while those on the northern limit yield less wide clear lumber. However, the following figures give a notion of average conditions:

Grade			Average value
Clear and select.....	20 per cent	at $40 per M =	$8.00
Shop.....	30 per cent	at 25 per M =	7.50
Common.....	30 per cent	at 15 per M =	4.50
Box.....	20 per cent	at 12 per M =	2.40
	100 per cent		$22.40 average mill run value.

These prices are for 1912. Since then there has been an increase of about 100 per cent.

Western yellow pine may be briefly described as a poor quality of sugar pine. It has practically the same properties and hence uses but does not yield so much high grade lumber because of the larger amount of pitch. This is not, however, a drawback when durability is desired and for rough construction lumber for use outdoors unpainted or in contact with the ground yellow pine is better than sugar pine. Nor for such purposes is its weight a drawback. It is a third heavier than sugar pine. The value of the average mill run may be computed as follows based on 1912 figures:

Clear and select.....	15 per cent at $35 =	$5.25
Shop.....	25 per cent at 20 =	5.00
Common.....	30 per cent at 15 =	4.50
Box.....	30 per cent at 12 =	3.60
	100 per cent	$18.35

Detailed figures by grades cannot be given for the average sale value of Douglas fir, white fir and incense cedar but they are lower than those of sugar and yellow pine because they supply lower uses. Douglas fir while preëminent for rough construction purposes is not soft enough to make good finishing and pattern makers' lumber. White fir does not season well, decays rapidly, is weak and not of large size so that the greater part of

it is used for boxmaking. Incense cedar finds its widest use as shingles altho it is occasionally employed for interior finish. The average mill prices at present common are:

	Per M
Douglas fir	$40.00
White fir	25.00
Incense cedar	30.00

The main difference between the logging methods used in this type and those so far considered is that steam donkey engines are commonly used in yarding. The large size of the timber, the density of the stands and the comparative evenness of the topography make this method much more economical than skidding with horses. A yarding crew consists of a dozen men and handles 25 to 40M per day. The donkey engines are placed alongside the logging railroads whenever possible so that the logs may be loaded on to the cars by steam after being yarded. Where the topography does not permit this a dry log chute may be used to get the logs from the yarding engine to the railroad. The average costs of a typical operation were as follows in 1915:

	Per M
Felling and bucking	$0.65
Yarding	1.80
Chuting (54 per cent of cut)	0.50
Loading	0.25
Railroad haul	1.50
Supervision	0.25
	$5.30

Large mills capable of turning out 250,000 feet in 24 hours are becoming more common because they turn out better lumber at less cost. Average figures for such a mill were as follows:

	Per M
Unloading logs in mill pond	$0.07
Milling	1.50
Maintenance	0.50
Yard charges	0.73
Planing (part only) and loading	0.90
	$3.70

Adding the logging and milling costs gives a total cost of $9 per M. Hence there is a possible margin for stumpage and profit

of $13 for sugar pine, $9 for yellow pine and Douglas fir, $5 for incense cedar, and $3 for white fir. Nor can these figures be increased ordinarily by the sale of tops or slabs for firewood because the local demand is small.

In man hours the costs of an average operation would be as follows:

	Man hours per M
Felling and bucking	2
To mill	7
Milling	7
	16

In addition to these labor costs there would be considerable charges for interest and depreciation in the case of milling and getting the logs to the mill.

Land Valuation. — The use of sugar pine land for farming is generally impracticable on any large scale because the slopes make irrigation expensive. In addition the shallowness of the soil and frequent outcrops of rock are obstacles to cheap cultivation. As a consequence there is no sale for land for this purpose with the exception of an occasional mountain meadow.

For grazing there is more demand for this type. It will support from one to two head of cattle or 10 sheep during the summer months on 40 acres and a fair renta' per acre is 10 cents. Hence the capital-value may safely be taken as $1.25 per acre using an 8 per cent interest rate.

The main reason why land in this type cannot be given a high value per acre for the production of lumber is that growth is slow during the early stages. This is, however, better than the returns from grazing and of more importance to the large owner than the possible use of a small fraction of his land for tillage purposes. Therefore it would seem that the highest use to which most of the type can be put is the growing of timber supplemented by grazing on lands where the reproduction will not be injured by the browsing of cattle or sheep. Furthermore these uses are in many cases supplemented by the values accruing from watershed protection whether the water so conserved is used for irrigation or power purposes.

Land Titles.— This subject may be quickly disposed of because the title conditions obtain here which have been already discussed in connection with the other tree types occurring in the western public land survey states.

CHAPTER XV

REDWOOD TYPE

General Conditions.— The redwood, Sequoia sempervirens, must be distinguished from its near relative, the big tree, Sequoia Washingtonia, because they are very different in many respects. They are unlike botanically, the wood has not quite the same commercial value, and their ranges are not identical. The redwood is confined to a belt about 10 miles wide and within 30 miles of the Pacific Ocean on the west side of the Coast Range in northern California and southern Oregon. Its distribution is well defined in the following quotation from Forest Service Bulletin No. 38:

> The Redwood is popularly thought to occupy a strip of country 10 to 30 miles wide, from the Oregon line to the Bay of Monterey, but these boundaries do not cover its actual distribution. Two thousand acres of Redwood, in two separate groups, are growing in Oregon along the Chetco River. South of the Chetco a continuous Redwood belt begins. By way of the river valleys and lowlands it increases its width from 10 miles, at Del Norte County, to 18 or 20 miles, and keeps on unbroken to southern Humboldt County. Here, for about a township, it thins out, but becomes dense again six miles north of the Mendocino line, and after entering that county widens to 35 miles, its greatest width. The Redwood belt ends in Mendocino County, but isolated forests of the species are growing in sheltered spots as far south as Salmon Creek Canyon, in the Santa Lucia Mountains, Monterey County, 12 miles south of Punta Gorda, and 500 miles from the northern limit of the tree along the Chetco River.

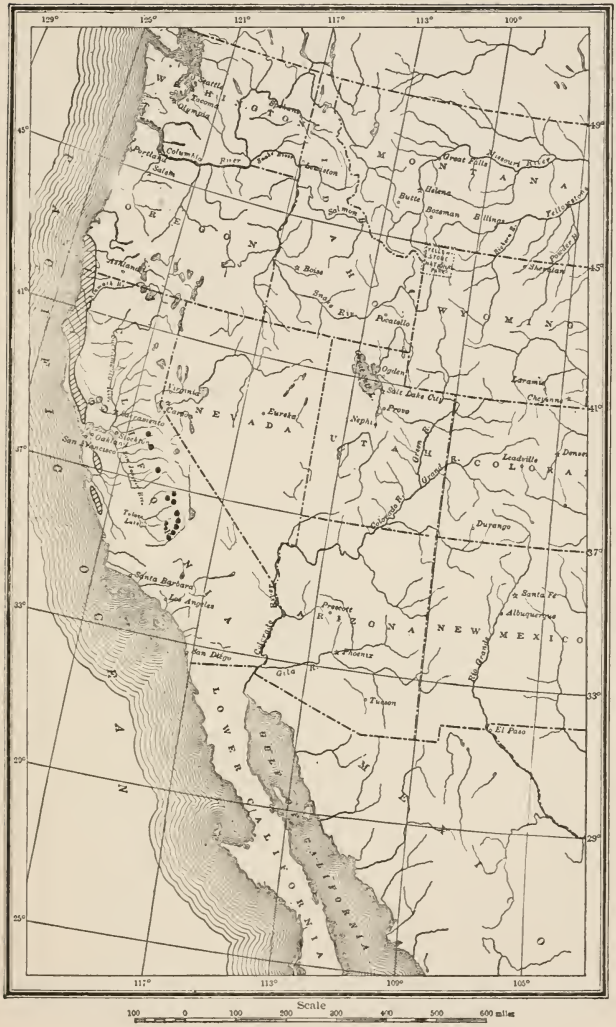

FIG. 12. Distribution of the Redwood and Sequoia Types

The climate is the controlling factor in the redwood's distribution. It is only found where there is at least 30 inches of rainfall during the fall and winter and constant sea fogs during the summer. This minimum precipitation is characteristic of the southern part of its range where the trees do not reach as large size as they do farther north. In fact the greater the rainfall the better the trees, always provided the growing season is long. This latter factor of temperature prevents the spread of the species north. A mean annual temperature of 50 degrees or 60 degrees is necessary with not less than six months free from frost. In other words, the climate is like that of the southeast at Charleston, S. C., for example, in the absolute amount of precipitation, and the range and duration of temperature, but there are two marked differences. The great evaporation of the southeast is checked by the summer fogs while there are no high winds such as sweep our eastern coast in the fall and winter. Hence the redwood grows under almost ideal conditions. There is a long growing season to give large diameter and height growth and enough moisture to not only further these but also permit of a fair degree of density.

These favorable climatic factors are still further enhanced by favorable soil conditions. Situated on the lower slopes of the coast ranges there is sufficient depth of soil together with the requisite drainage to prevent sourness. The most desirable soil conditions are found on the flats along the streams. Here the soil is fertile, deep and well watered and the redwood reaches a diameter of 20 feet and the magnificent total height of 350 feet, the tallest of all American tree species. With it are associated hemlock and Sitka spruce but the redwood usually makes up at least half of the total number of trees. The virgin stands per acre in this flat subtype range from 150M board feet in the northern part of its range to about a third of that in the south.

The other subtype recognized by Fisher, the slope subtype, is located on the relatively drier and more shallow slopes. With less favorable conditions for redwood the competition from other species is keener, such a large size is not attained and growth is less rapid. The following table summarizing the principal facts

in regard to each subtype also offers a basis for comparing the two:

Composition by number	Flat	Slope
	Per cent	Per cent
Redwood	80	60
Hemlock	15	20
Spruce	5	5
White fir		10
Tanbark oak		5
	100	100

	Feet	Feet
Maximum diameter	20	10
Maximum height	350	225
Growth in 30 years:		
Diameter	16	9
Height	80	55

Timber Values.— There are only two reasons why the estimating of redwood need cost more than a very moderate sum per acre. The mere size of the trees is the least important of these two but large trees are somewhat harder to estimate rapidly than medium sized ones. Redwood may, however, occur on slopes which are difficult to negotiate. But against these two unfavorable factors can be set the favoring ones of accessibility, uniformity of composition, and low value of the standing trees per M. Hence it is seldom necessary to estimate more than 10 per cent of the total stand and the cost per acre should not exceed five cents for tracts of any size.

As stated above stumpage values are low. The prime reason for this is the freight charge to the eastern markets but it must be remembered that redwood in spite of its large size is a soft, weak wood mainly used for rough construction purposes. This is the way in which its great durability in contact with the ground and when exposed to the weather can be best taken advantage of. In other words it is an excellent wood for shingles, rough boards, boxes, and railroad ties where the traffic is not heavy. The average sale value in 1917 at the mill as stated in Forest Service Bulletin No. 768 was $21 per M. This was

much above the pre-war value because for the five years between 1916 and 1909 inclusive the average was $14.35 per M. This latter figure is naturally a safer one to use in determining the margin available for stumpage than the abnormal value of 1917.

Logging and milling costs present no unusual features except that the large size of the timber makes steam logging the most economical. But this merely tends to reduce costs if handled on a large enough scale. It is, of course, no business for a small operator. The holdings must be large, the logs skidded by steam, a railroad built to haul the logs, and heavy sawmill machinery employed. In 1900 Fisher found that costs were as follows:

	Per M
Logging	$3.00 to $5.50
Milling	3.00 to 3.50
Loading	0.25 to 0.50
Freight to local towns in California	2.50 to 4.00
Office costs, etc.	2.00
	$10.75

Converted to labor hours per M these costs would be as follows:

	Man hours plus fixed charges
Logging	7
Milling	7
	14

With a sale value of $11 to $13 per M for rough lumber and $18 to $25 for clear boards there was naturally little margin for stumpage. Even today redwood is worth less than $5 per M standing.

Land Values.— Fisher estimates that but two per cent of the redwood type may be classified as " flat " so that the tillage possibilities are not great. At best it will only pay to farm comparatively small areas. There is no chance for the development of agricultural communities. Grazing is only feasible on the drier ridges where the stands of redwood and its associated tree species are open enough to permit grass and weed growth. Unquestionably the highest use to which most of this type can be put is for the production of timber. Except on the dry ridges reproduction is vigorous enough and growth sufficiently rapid to justify the

land being held for a second crop. This is one of the few types in the United States which can average 1000 board feet per acre per annum under management. This means that the soil is worth at least $10 per acre for timber production. With fire eliminated — and this is not a difficult task in the humid climate of the type — there is very little risk since insect and fungus enemies are not abundant.

Titles.— With only a short chain of title possible resting upon the original grant from the Federal Government and each square mile surveyed there can be little difficulty in identifying, describing or passing title to redwood land. The only precaution that needs to be observed is to make sure that no fraud was practised in obtaining title from the United States. The methods used in the early days to secure timber lands under the homestead and timber and stone laws were not always exactly regular.

CHAPTER XVI

BIG TREES — SEQUOIAS

What has been said about the redwood applies with certain exceptions to the big trees. The wood has the same general uses, logging methods are identical, and costs, sale values, and stumpage prices are similar. The major differences are in distribution, and vigor of growth and reproduction. The groves of big trees are the remnants of much larger forests which have been restricted in area by climatic changes and more vigorous competitors. Whether they will be able to increase in area with real protection from fire, insects and fungi is a question. At present the big tree is confined to about 15 localities on the lower western slopes of the Sierra Mountains in California aggregating not more than 10,000 acres. In altitude the species is found from 5000 to 8000 feet above sea level and reaches its best development on cool, moist, sandy or rocky soils in full enjoyment of the sunlight. Unlike its cousin, the redwood, the stands are rarely more than 50 per cent big tree by number. Sugar pine, white fir and Douglas fir are its commonest associates.

Little difference exists in the quality of the wood from the two kinds of sequoia. Both have the same uses. Even their size does not vary enough to affect their market value. The redwood reaches a greater height while the maximum diameter of the big tree is 30 feet as against 20 feet for the redwood.

As an investment for timber production the big tree does not offer the advantages that redwood stands do. The latter occupies a well defined and extensive area in which the climatic conditions are favorable for vigorous reproduction and rapid growth. The big tree, on the other hand, seems to be merely holding its own in certain restricted localities. It is not even certain that its competitors would not give higher returns on the same sites.

CHAPTER XVII

DOUGLAS FIR

General Conditions.— Altho the Douglas or red fir is one of our most widely distributed timber trees and is found throughout the Rocky Mountain and Cascade ranges from Northwestern Texas to British Columbia it is not the dominant species over wide areas except in the extreme northwestern part of the United States. There it occurs in nearly pure stands with high yields. In California the type occupies the middle slopes of the west side of the Cascades between the sequoia and sugar pine types. All of western Oregon is covered with it from the summit of the Cascades to the Pacific Ocean except the valley of the Willamette River, a sheltered basin lacking in precipitation. Northward in Washington there are no such dry valleys and the type is the dominant vegetation west of the Cascades.

Altitudinally the type may occur anywhere between 0 and 6000 feet above sea level but in accordance with the laws of climate is only abundant at sea level in Washington. Southward in Oregon and California it is commonly forced to keep to the mountain slopes by tree species like the sequoia which are better adapted to the warmer, drier climate and even on these slopes it prefers the cooler north slopes.

With a north and south extent of 500 miles and an east and west width of 150 miles there is naturally considerable variation within the type in climate. The north and south extent is less important, however, than the distance from the Pacific Ocean. The moisture laden winds come from there and ascend the steep slopes of the Cascade Range. At the point where they are cooled down to the temperature at which they give off their moisture freely the Douglas fir type is most vigorous. While it can exist with an average annual precipitation of 50 inches it does better where the total annual rainfall is 50 to 100 per cent

greater. In fact within its boundaries occurs the heaviest measured rainfall in the United States, 100 inches in 12 months.

The growing season is relatively long as compared with localities of the same latitude in the eastern part of the United States. This is because the Pacific Coast climate is much modified by the warm moist winds from the ocean. Hence there are no months at Seattle when the mean temperature is below freezing. Taking the type as a whole in the United States from northern California to the Canadian line the growing season is approximately six months long. Temperatures too cold for tree growth are rare from April thru September.

As explained above this type is most abundant on the middle slopes of the western side of the Cascade Range. This includes the headwaters of the Illinois and Rogue rivers, the entire course of the Umpdua, and the upper reaches of the Willamette and its tributaries in Oregon. Between the States of Oregon and Washington the Columbia River cuts thru the Cascade Range at right angles but has very little effect on the distribution of the type. Its northern tributary, the Cowlitz River, however, is entirely within the type and the same applies to the other principal rivers of western Washington, the Chehalis, the Queniult, the Skagit, and the Nooksak. All of these are characterized by short, steep courses, with an abundance of water.

As might be inferred from the steep to moderate slopes which the type occupies the soil is fairly deep but yet not free from outcrops and loose rocks. In origin it is partly glacial and in Oregon and California residual or volcanic.

While Douglas fir is the dominant species in the type it has many associates on the sites which it does not possess the special ability to preëmpt. For example, in the river bottoms in the interior and along the seashore red cedar, Sitka spruce and Lawson cypress share the ground with it. This is called the fir cedar subtype. On the drier lower slopes above the shore line and river bottom the fir is preëminent. Here it finds the deep, loose soil, the long growing season and abundant rainfall which it requires to reach its maximum development. Higher up, that is, extending from 3000 to 4000 feet above sea level to 6000 or

7000, the Douglas fir is mixed with western hemlock and several species of balsam. All the tree subtypes referred to above occur in the western slope of the Cascade Range. Its eastern side being sheltered from the moist Pacific winds has much less precipitation. As a consequence the stands are more open and the Douglas fir shares preëminence with western larch, a species which makes only moderate demands upon soil moisture. A comparative stand table for these different subtypes under virgin conditions is given below:

	M
Fir-cedar	60
Pure fir	100
Fir-hemlock	75
Fir-larch	30

Accurate growth data for all the species found in the type are not available, but good figures do exist for Douglas fir and it seemed wise to make estimates for the other species in order to give at least a relative notion of their growth.

Species	Diameter		Height		Yield	
	50 yrs.	100 yrs.	50 yrs.	100 yrs.	50 yrs.	100 yrs.
Douglas fir	15″	24″	102°	154°	28M	79M
Red cedar	30″	slower	growing	than	Douglas	fir
Lawson cypress	50″	"	"	"	"	"
Sitka spruce	30″	"	"	"	"	"
Western hemlock	20″	"	"	"	"	"
Grand fir	10″	"	"	"	"	"
Amabilis fir	20″	"	"	"	"	"
Western larch	25″	"	"	"	"	"

Timber Valuation. — The following quotation from Compton's "Organization of the Timber Industry" sets forth the early conditions in regard to stumpage prices of Douglas fir.

"During the eighties the prevailing price of stumpage in Washington was not over 15 cents per M feet. Between 1898 and 1908 prices trebled. A stand of eight million feet (estimated) was bought in 1891 for $800 or for 10 cents per M feet. In 1909 the same tract was sold for $18,500 or for $2.31 per M feet. As late as 1903 a stand of 472 million feet (estimated) was purchased

at 12.9 cents per M. In 1907, 59 cents per M was offered for the entire tract. A great deal of the timberland of the Pacific Northwest has been alienated from the public domain under the general land laws. Some of the timber in select areas has thus been sold by the United States at less than four cents per M feet. Similar conditions have largely prevailed in Oregon which now has a greater supply of merchantable timber than has any other state. Because of the extremely low original prices, a very large relative increase in stumpage prices in the Pacific Northwest does not necessarily imply a great absolute rise."

No figures for an extended period exist for the subordinate species in the type such as hemlock, balsam, cedar, etc., for the reason that they have only recently become merchantable at all. They are now, however, being cut more and more and command an average stumpage value of not more than $1.50 per M in this type.

As far as use value is concerned Douglas fir easily leads all its associated species. In fact it ranks second in the lumber cut of the United States and the amount produced annually is only exceeded by the combination of three southeastern species usually grouped together under the name of yellow pine. This fact alone is enough to show that it is strong, easily worked wood in demand for general construction purposes, for a wood must answer these requirements to stand high in the annual lumber cut. In comparison with white pine it is harder but stronger, while the better grades of yellow pine exceed it slightly in strength and durability. It is consequently eagerly sought for such a wide variety of uses as railroad bridges, ties, boat building, flooring and interior finish. In 1910 the main uses to which the lumber was put were as follows:

	Per cent
Mill work	87
Tanks and silos	4
Car construction	4
Boats	2
Pumps and wood pipe	1
Other uses	2
	100

On Nov. 24, 1920, the following prices prevailed f.o.b. the mills for the principal grades of Douglas fir:

Flooring (vertical)	$40	per M
Finish	35	"
Drop siding	35	"
Boards and shiplap No. 1	19	"
Dimension No. 1 S & E	16	"

The average mill run price in 1912 was $11.58.

Lawson cypress is important locally but does not reach the general eastern market at least under its own name. In the first place there is not enough of it to make it an important factor in the lumber market and secondly it is used for purposes which do not demand high priced lumber. Hence, while it is a common wood in Oregon for fence posts, railway ties and poles, it is only occasionally cut into lumber and then only for local consumption. Its sale value per M is accordingly low. At the mills it does not exceed $10 per M for the mill run.

Red cedar is of more than local importance but not as lumber. It is in the form of shingles that it has invaded the eastern market. This western species is not to be confused with the eastern red cedar which belongs to another genus. The latter finds its highest use as pencil wood and usually grows too small for high grade shingles. The western red cedar on the other hand is a magnificent tree four to six feet in diameter and yields the widest shingles on the general market. But even for this purpose the mill run value will not exceed $15 per M.

Sitka spruce is another species which has not been sold in the general markets, at least before the Great War. Recently, however, it has been in great demand as airplane stock where its lightness and strength meet a special need and help to relieve the strain on the producers of eastern spruce. The two woods are essentially the same in structure and properties so that it is safe to predict a widening market for Sitka spruce when it can be supplied to the manufacturers of musical instruments, pulp manufacturers, etc. At present, however, the mill run cannot be sold for more than $15 per M.

Western hemlock is in an even worse plight. It has no special

high value uses but merely makes good rough construction lumber. For a long time, therefore, it was not cut at all and even now is only shipped east when cut in special sizes of extra length or width. Hence, the mill run never averages better than $10 per M.

Balsam is another low grade species the bulk of which must be used locally for boxes, cheap finish and other purposes for which a soft, weak wood which is not durable may be used. Its mill run also averages about $10 per M at the point of manufacture, and this is true in spite of the fact that large sizes may be obtained.

Larch commands a better figure because it is fairly hard and much more durable. It can, therefore, be used for flooring, railway ties, and general construction work. Its only fault is that it is liable to split if cut into inch boards of over six inches in width. Consequently all the clear lumber goes into flooring which is always made in narrow widths. This brings up the average mill run value to about $12 f.o.b. the mill.

Logging costs in the Douglas fir present certain marked differences from those in other types because the conditions to be met are unique. Felling and bucking are difficult on account of the large size of the timber. It is obvious that different methods must be used with a tree containing 8 to 16 foot logs and five feet in diameter at the top end of the first log than are employed for ordinary sized trees. In the first place a spring board is commonly used to put the sawyers up above the root swelling. Then the fallers need so much time to saw thru the tree that they do none of the notching, but a head chopper takes over all this work. Even the bucking is often done by special buckers by contract or better yet the logs are hauled in to a steam saw in as long lengths as possible and hand work thus eliminated in this operation. But the situation has its relieving features. The cost of felling and bucking are low per M because of the large size of the trees. Where a single tree contains 5 to 10 M feet it can readily be seen that the cost of felling and bucking will be much less per M than for small trees.

Ordinary skidding methods are likewise wholly inadequate. Donkey engines are the only successful method by which suffi-

cient power may be developed to handle the immense logs. Oxen and horses have proved futile. But if properly applied, steam skidders give low costs per M when there is sufficient timber to justify the heavy initial investment.

The large size of the timber has also dictated the methods employed to transport the logs from the skidding yards to the mills. There are plenty of drivable streams in the region for timber of ordinary size but they are too steep, too rocky, and too crooked to carry large logs. Hence railroads had to be built into the timber even tho it is all softwood and not hardwood. But railroads are the most economical method of log transport where there is enough timber to cover the heavy initial investment. In fact logs in this type cost as little per M laid down in the mill pond as those from any type simply because there are heavy stands per acre and steam can economically replace hand labor. This is more especially the case where rafting on salt water can take the place of rail transport. This, of course, only applies to timber on tidewater but a large percentage of what has been so far cut has been thus advantageously situated.

Milling charges do not differ much from those that prevail in other regions altho the saw, carriages and other equipment have to be unusually large. The high cost of labor seems to offset any advantage there is in the large logs.

Average costs per M from the stump to the car in 1915 may be summarized as follows:

Felling and bucking	$0.60	or one and one-half man hours.
Yarding and loading	2.00	or three man hours plus fixed charges.
Transport to mill:		
By raft	1.25	or five man hours plus fixed charges.
By railroad	2.00	
Milling	4.00	or four man hours plus fixed charges.
Total cost	$7.85	or $8.60

Using an average logging cost of $7.25 per M there are the following margins possible for stumpage and profit with the species which occur in this type:

	Per M
Douglas fir	$5.00
Cypress	3.00
Red cedar	5.00
Sitka spruce	5.00
Hemlock	3.00
Balsam	3.00
Larch	5.00

Land Values.— Of the three possible uses of Douglas fir land exclusive of the timber and minerals, tillage, grazing and timber production, the first will undoubtedly give the highest returns where the conditions are favorable. But tillage requires gentle slopes, reasonable freedom from rock outcrops and loose stones, and a ready market, and this combination of characters is seldom met with in the type. The slopes are usually too steep, especially if irrigation is to be employed, the soil is frequently too shallow, and the local market will only absorb a limited amount of produce while the general market is across the continent and only accessible for high grade products. For example, northwestern apples have earned an enviable reputation but simply because it is only the very best grades that will stand the freight charges that must be paid to reach the general market. Hence, very little of this type has yet been cleared. The famous agricultural sections of the northwest the Palouse, the Willamette, etc., are treeless sections which have been rendered fertile by irrigation. In other words it has been more profitable to irrigate arid regions than to clear off the timber in the sections where there is abundant moisture. Another factor which needs at least passing mention is that even in the humid parts of the northwest there is a deficiency of moisture during the summer; for example, at Olympia, Washington, only three inches of rainfall during June, July and August or merely 5 per cent of the total annual precipitation of 55 inches. This illustrates why irrigation is desirable for many crops even in places where there is a superabundance of moisture in the winter. Hence, the cost of irrigation must usually be added to that of clearing in the Douglas fir type. Three factors, then, make tillage a doubtful proposition, the heavy cost of clearing, the steep slopes, and the cost of irrigation. Grazing

is also little practiced within this type for the very good reason that the trees stand so close together that very little grass can grow underneath them. The only exceptions to this general rule are occasional localities where the fir-larch subtype is open enough to permit some grass growth but these are practically negligible.

Hence it follows that taking the type as a whole the production of timber is the highest use of the soil. There is only one unfavorable factor. That is the distance to market. But improvements in transportation and growing scarcity of timber in other regions are bound to lead to an increase in stumpage prices. In fact it seems safe to figure that these prices will be at least $10 per M within the next rotation of 100 years. With this assumption and using an interest rate of 3 per cent the value of the land within the type is $22 per acre.

Titles.— Land titles present no special problems. In surveyed sections they are easy to trace since the land has been obtained from the Federal Government within a short period either thru the homestead or timber and stone claim laws or purchased outright from the State or land grant railways.

CHAPTER XVIII

ALASKA

Climate and Topography.—As a preliminary to a description of the timber distribution in Alaska an understanding of the climatic factors is desirable. In the first place it is necessary to correct the general impression that low temperatures preclude all tree growth. This probably arises from a failure to understand that Alaska is 1400 miles long. In other words, it would reach from Cape Cod to Key West if set down on the Atlantic Coast. Hence the southern third is outside the Arctic Circle. Sitka, the capital, for example, has an average annual temperature equal to that of Philadelphia. This is true even tho Sitka is in the same latitude as northern Labrador because of the warm winds which blow off the Pacific Ocean. These are also responsible for the heavy precipitation of southern Alaska where 80 inches per annum is not uncommon. The northern or continental part of Alaska has an entirely different climate, however. This part may be said to consist of a basin, the Yukon and Kuskokwim river valleys with the Alaska Range on the south and the Endicott Range on the north. The former is particularly rugged, running up to 15,000 feet above sea level in many places and attaining the magnificent altitude of over 20,000 feet in Mt. McKinley the highest peak in North America. This means that many of the mountains are too high to permit tree growth on them.

The Endicott Range while not so lofty is, however, high enough to also have considerable areas above timber line. In all, approximately one third of the territory is so far above sea level that tree growth is out of the question. Another third of the land area is also treeless but for another reason. This is the so called " tundra " upon which tree growth cannot exist because of the short growing season. To this category belong the slopes draining into the Arctic Ocean and Behring Sea. The glaciers and snowfields are also without tree growth.

There remains less than one third of the land area, 27 per cent to be exact. Of this 6 per cent is capable of producing large sized saw timber. It is confined to southwestern Alaska whose climate has already been described. The remainder of the timber producing area, 21 per cent of the whole territory, has, however, an entirely different climate. The conditions at Fairbanks in the Yukon Valley may be taken as typical of this region. The mean annual precipitation is 15 inches. The winters are long and cold while the summers tho short are warm. July, for example, has an average of 57° F. Furthermore, there is almost continual daylight during the vegetative season. Consequently the upper surface of the soil thaws out sufficiently to permit vegetative growth while the frozen layers beneath supply ample moisture by capillary attraction. There results, therefore, rapid growth in spite of the short season and scant rainfall. White spruce (Picea canadensis) and three cottonwoods (Populus balsamifera, trichocarpa and tremuloides) and white birch (Betula alaskana) are the dominant species with black spruce (Picea nigra) and tamarack (Larix alaskensis) much less common. These trees reach their best development in the deep soiled river bottoms and are short and stunted on the hillsides. Diameters of more than 18 inches breast-high and total heights of over 50 feet are rare. The stands are relatively open so that the yields per acre are not large. In fact the wonder is that trees do so well rather than that they are not larger and denser. Scant rainfall and a long winter are only partially offset by the long summer days and abundant supply of ground moisture.

The Coast Forests.— By contrast with the interior forests the coast timber seems magnificent. It is in fact a northern extension of the luxuriant Douglas fir type of Washington and Oregon. The composition is, however, considerably altered by the lower temperatures. Douglas fir is no longer found but the dominant species are western hemlock (Tsuga heterophylla) and Sitka spruce (Picea sitchensis). Western red cedar (Thuya plicata) and yellow cedar (Chamæcyparis Nootkatensis) occur sparingly in southwestern Alaska. Species of little commercial importance which are more or less abundant in this type are:

Lodgepole pine (Pinus contorta).
Black Hemlock (Tsuga mertensiana).
Alpine fir (Abies lasiocarpa).
White spruce (Picea canadensis).
Black spruce (Picea mariana).
Balsam poplar (Populus balsamifera).
Black cottonwood (Populus trichocarpa).
Birches (Betula).
Willows (Salix).

From the description given above it is evident that hemlock and spruce are the species which determine the stand per acre. Kellogg estimates that together they constitute 95 per cent of the total average volume per acre with the hemlock much more abundant and making up 75 per cent of this total. For an average stand per acre a midway location must be chosen. Around Cook Inlet the stands are distinctly less in volume than at the southern end of the territory where it touches British Columbia. This is because the trees do not attain such good diameter and height growth in the north. Diameters of over four feet and heights of more than 100 feet are not common north of Juneau. South of there, however, the stands often average better than 25,000 feet per acre. From these heavy stands there is a gradual decrease northward in the diameters and heights until around Cook Inlet the timber averages two feet in diameter and 60 feet in height with stands averaging less than 10,000 feet per acre. For the type as a whole 15,000 feet is a conservative figure.

Except for a small amount of insect and fungus damage the type is remarkably free from disease. This is undoubtedly due to the absence of fire, a result of the heavy precipitation. The ground is covered with a thick mat of undergrowth and moss which is kept continually wet by the ocean fogs. Hence, the trees grow unchecked until they are overmature unless the soil is so thin that the wind overthrows them. Such damage is, however, slight except near the upper limit of tree growth where the mountain slopes are steep and the soil is shallow.

Growth cannot be satisfactorily set forth on account of lack of data. There are only a few figures available for the best sites.

At the southwestern end of Alaska the following diameters were attained in 100 years' growth:

	Inches
Sitka spruce	18
Red cedar	18

Farther north the growth would, of course, be slower because of the shorter growing season so that the average for the type would be comparable to growth conditions in the spruce type of the northeastern United States where the yield per acre in 100 years is 15M board feet.

Interior Forests.— The composition of the forests in the Yukon and Kuskokwim River valley basins has already been referred to above. All the species are specially adapted to cold, dry climates. White spruce, Picea canadensis, is the most abundant and the most important commercially. It is the only species that is suitable for even small saw timber and also shares with the other species the burden of supplying the firewood needs. Birch and cottonwood are, however, considered better for this latter purpose.

With the variation in soil conditions there is a corresponding variation in the composition of the stands. In the deep soiled bottomlands along the streams pure stands of white spruce sometimes occur but a mixture of this species with cottonwood and birch is more common. On the slopes immediately above the stream bottoms the same mixture prevails but the individual trees are distinctly smaller and less vigorous. On the ridges tree growth is scattered and stunted and generally confined to the depressions. On such poorly drained sites black spruce is the common species.

Growth is slow even in the bottoms. The following data are taken from Kellogg's " The Forests of Alaska ": *

	Annual growth	
	Diameter, inches	Height, inches
White spruce	$\frac{1}{4}$ to $\frac{1}{14}$	10
White birch	$\frac{1}{11}$	.....

* Forest Service Bull. 81, " The Forests of Alaska," R. S. Kellogg, 1910.

Yield varies with the kind of timber which in turn depends upon the soil conditions as has already been shown, consequently the heaviest stands are those of pure or mixed white spruce in the bottoms. Ten thousand board feet per acre is not uncommon but the average is more nearly half that. The slope and ridge stands yield much less per acre. Twenty cords per acre is high for the former while much of the latter growth is too small to be merchantable.

Fire is the principal cause of damage. It is especially destructive after lumbering and many thousands of acres have been seriously if not permanently damaged in this way. In a region where tree growth has so much to struggle against fire may be the deciding factor in preventing the return and spread of a forest cover. No serious insect or fungus diseases have been reported.

Timber Valuation. — Since climatic and market conditions are so radically different for the different parts of Alaska it will be necessary to consider timber estimating, logging costs, sale and stumpage values separately for the coast and interior forests.

An estimating crew in the coast forests outfits in one of the seaboard towns like Seattle, Sitka or Juneau and goes by boat to the tract to be looked over. An outfit of several units or one with a large amount of work ahead should by all means have its own vessel. Then the men can live aboard and be more comfortable than they would ashore. A power craft varying in size with the number in the crew makes an ideal boat for this purpose.

Arrived at their destination a base line should be laid out along the beach. Then the strips may be run into the timber. Only a small percentage, relatively, need be estimated because the composition is usually uniform. But the actual running is different because of the rough topography, heavy undergrowth and uneven surface. The slopes from sea level are always abrupt and covered with rocks and boulders which have rolled down from above. While the undergrowth is dense it seldom covers up completely the holes between the boulders but merely serves to conceal them. Furthermore, it is generally so wet from fog or rain that the estimating crew is thoroly drenched before going 100 yards from the beach. These things do not make for rapid

progress when the trees are close together even tho not large. In fact 20 strip acres a day is a good average. Hence, the cost per acre can seldom be brought down less than 5 cents even on tracts of more than 1000 acres. For smaller tracts it would of course be more.

The typical logging job is handled much as follows: A crew of two to five men agree to put the logs into the water for $3 to $5 per M. After felling the tops are lopped and the tree put full length into the water. In the early days there was plenty of timber that could be either felled directly into tidewater or warped to the highwater mark by hand. But most of these chances are gone now and it is more common to use the slack rope system of power skidding with a donkey engine mounted on a scow. In this way a distance of 900 feet can be covered.

Once landed in the water it is generally an easy matter to gather the logs into a raft and tow them to the sawmill which is also located on tidewater. To get fair weather for these operations logging is usually confined to the summer months. At the mill the full length logs are bucked and then passed by the saw, edger, trimmer, etc. Seldom can lumber be manufactured for less than $15 per M where all expenses are included.

Sitka spruce, the commonest species, cuts the following percentages of grades on the average:

	Per cent
Clear	15
No. 1 common	20
No. 2	15
Box	20
Dimension	20
Cull	5
	95

For the mill run the pre-war price was $15 per M but the demand for airplane spruce has, of course, forced this up. For hemlock the demand has been and is less so that the mill run value is at least $2 lower. Cedar goes mostly into shingles where it has brought a mill run wholesale price of about $18 per M. Consequently there is a very small margin for stumpage and profit.

On the Tongass National Forest the following stumpage prices prevailed in 1917:

	Per M
Cedar	$2.50
Spruce	2.00
Hemlock	1.00

In general, therefore, it is safe to say that there is very little profit in manufacturing lumber in southwestern Alaska. Wages and supplies are high. Unless there is an active local demand mills cannot operate successfully. Competition on the general market is out of the question.

The manufacture of wood pulp is a different proposition. The finished product can be marketed successfully in the Pacific Coast cities to the south like Seattle, Portland and San Francisco. In addition to accessible timber there are many excellent water-powers within reach of tidewater. Consequently pulp mills are being installed even tho a large initial investment is required which makes their minimum period of profitable operation at least 10 years. Both hemlock and spruce are being used.

The shingle business is profitable enough in normal years to justify placing an Alaskan product on the general market where red cedar is abundant. But it only occurs sparingly. The mills which have been operating are therefore small affairs merely supplying the local market.

While all woods work is best carried on along the southern coast in the summer time, estimating, at least, in the interior can be done most advantageously during the winter. There are no mosquitoes then, the wet places are frozen over, and there is enough snow for snowshoes or skies. Of course it is cold, but a dry cold in which much lower temperatures can be borne than in a wet climate. Travel, off the short railroad lines, is entirely by dog team, reindeer or on foot.

Two factors prevent rapid and cheap work. The timber is small and the bunches of merchantable trees are unevenly distributed. As explained above the character of the soil determines in large measure the composition and quality of the stands. Hence the timber fit for sawing is confined to the river bottoms

and is limited in extent. In fact this is much like a second growth woodlot region in size of the timber and extent of the stands.

The logging methods are different, however. While the mills are small they are permanent and draw their lumber from a considerable area by driving the streams. This means summer operation at the mill but the woods work may well be carried on during the winter. The snow is not heavy enough to interfere. It is merely sufficient to make skidding to the stream bank easy; consequently the *modus operandi* is similar to that on small jobs in the northeastern United States. The trees are felled and bucked early in the fall and then the logs are skidded to the water's edge when the snow comes. There they stay until the spring break up carries them to the mill.

On account of the high cost of supplies and consequent high wages logging costs are much above ordinary standards. Kellogg reports that in 1909 the Fairbanks mills were paying $20 per M for ordinary spruce logs and $25 for extra long ones. Most of this charge represents logging costs because the Land Office was only charging a stumpage price of $1 per M for timber on Government land. There is, therefore, some compensation to the mill operator in the sale values of lumber. Again quoting Kellogg "common lumber brings about $35 per M at Fairbanks; boat lumber, which is of extra length and must be entirely sound, $80 a thousand." Allowing $6 per M for milling and yard charges there is a probable margin of $5 to $10 per M for profit. Expressed on an acreage basis, the net yield per acre would not ordinarily exceed $150 for lumber. To this might in some cases be added $20 for cordwood, but usually cordwood cutting is a separate operation. Birch and spruce bring the best prices, $10 a cord in Fairbanks in 1909 and $6 to $8 on the river bank. The usual price for cutting was $4 at that time so that there is a margin of about $4 for profit, the stumpage charge of 25 cents being negligible. Hence a good stand of cordwood averaging 10 cords per acre would yield a net return of $40.

Land Values.— When land is not mineral bearing there is a limited range of possible uses in Alaska. Tillage in the southwestern part is greatly restricted by the small demands of the

scant population and the limited area of soil free enough from stones. A dense population, of course, forces the cultivation of even the steepest and rockiest soils but there is only one town with a population of over 10,000 people and not more than a half dozen with 1000 or more people. Taking the territory as a whole there is only one inhabitant to every nine square miles. Hence, even in the neighborhood of the larger towns, tillage land does not bring a high price. An additional reason is, of course, the climate which sets very definite limitations on the variety of crops. These three factors, the small amount of level, stone-free soil, the limited demand, and the rigorous climate have kept the price of agricultural land low even in southwestern Alaska and in the central part of the territory they are even more restrictive. It is only in the vicinity of the larger towns that more than $20 an acre may be obtained for stump land to be used for tillage.

The use of cutover land for grazing likewise offers no adequate market for the great bulk of timberland. Grazing never can become an important industry because there is not the chance to produce feed to carry the stock thru the long winters. This holds true in spite of the fact that horses have been known to winter in the interior without shelter. They pawed thru the light snow and subsisted on the dried grass, but this was mere existence.

For the production of timber the lands have a low valuation because even in the southwestern portion growth is relatively slow. In the interior the yields are so meagre that only very low returns can be expected from land devoted to timber production. In fact only the best of the coast forests will show land values of $5 or better for timber production and yet this is the highest use to which large portions of Alaska can be devoted. In fact the burden of proof should always be upon the other possible uses. In other words, while the returns from timber production *per se* are low they are much greater than from tillage or grazing in practically every case. In addition the indirect returns of the forest, its stream protective value especially where water powers are concerned and its æsthetic value should always be considered.

Titles.— Since the township system with sections a mile square is being extended to Alaska its land title problems are no different from those of the newer parts of the west. Tracts are easy to locate on the ground and claims of title are short and hence free from complications.

CHAPTER XIX

PORTO RICO

General Conditions.— As in temperate climates the amount of available moisture is the controlling factor in tropical tree distribution. This is the amount left in the soil after that evaporated and that which is run off is deducted from the total annual precipitation. For Porto Rico the latter varies from 169 to 21 inches. The trade winds are the dominant influence. Where they blow directly off the sea the rainfall is abundant but where they must rise up over a mountain range the leeward side is invariably dry. This accounts for the great variation in annual precipitation. The south or leeward side is sheltered from the trade winds by three ranges of mountains which comprise the greater part of the islands. Hence it is only the northern slopes of these mountains that are well enough watered to support vigorous tree growth because the evaporation and runoff are so great in the tropics that the total annual precipitation must be at least 60 inches to support dense vegetation. Its distribution is a matter of secondary importance since many tree species are able to endure a prolonged dry season by shedding their leaves.

The great evaporation due to high temperatures has already been referred to above; 76° F. is the annual mean for the whole island. This means, of course, that there is no cessation of growth thruout the year by reason of cold.

The effect of the mountain ranges on the distribution of rainfall has already been described. To give a more definite picture of the island it is merely necessary to add that only 20 per cent is plains country while the remaining 80 per cent is made up of mountains ranging in elevation from a few hundred feet above sea level to a maximum of 3400 feet. From the mountains flow over 1300 named streams of which the Plata River is the largest and longest.

Unfortunately not enough is known about the tree distribution

to make tree types based on differences in soil conditions as well as climatic differences. That can only come with more intensive study than even was possible for L. S. Murphy in his careful examination of the forest resources of the island.* In view of more detailed information his types are followed, viz.:

	Per cent
1. Mangrove type	8
2. Dry tidal woodland type	..
3. Moist deciduous type	7
4. Rain forest type	62
5. Dry deciduous type	23

The area percentages do not represent present acreages but the areas contained within the various types now and before the settlement of the island.

The first, or mangrove type, is confined to the margins of tide water not subject to strong wave action and on the northern and eastern sides of the island where the precipitation is high. In other words, it needs protection from direct wind and abundant moisture. Hence, on the leeward south and west portions of the island where the rain bearing winds are shut off by the mountains the type is only found along the mouths of the larger streams where the sea water is diluted enough to offset the lack of rain water. Commercially the mangrove type is valuable for two purposes, firewood and tanning material. Virgin stands should yield six cords per acre of fuel and 10 tons of bark, but there are few such stands in Porto Rico because this type is usually found close to the settlements and has consequently been heavily exploited.

Immediately above the mangrove swamps on the sandy and gravelly beaches occurs a type which has become purely man-made in its composition. This is where the introduced cocoanut palm has taken root most readily until it is characteristic of the West Indies that the shores of the sheltered coast line should be fringed with stands of this exotic species. In fact it is impossible to determine at this time what the original species were but rather

* U. S. Forest Service Bulletin 354, "The Forests of Porto Rico," L. S. Murphy, 1916.

than name it after the dominant tree at present Murphy has preferred to call it the "dry tidal woodland type."

The next two types contained the greatest amount of timber before settlement disturbed natural conditions because they occupied the portions of the island that are favored with heavy precipitation. The first of these, the moist deciduous type, is confined to areas having at least 60 inches of rainfall but with a short but distinct dry season which forces many of the trees to shed their leaves. Most of the type has been cleared for tillage but a few remnants indicate its composition. Tabanuco—Dacryodes excelsa Vahl — is the only important species which can be used as a substitute for softwood. Its wood is similar to that of yellow poplar and the tree is also found in pure stands so that it may be logged cheaply. The other commercial species in this moist deciduous type are hardwoods not suitable for general construction work but mainly used for cabinet work.

The rain forest type, on the other hand, which is characterized by the lack of a dry season and abundant precipitation thruout the year has several important species which have wood soft enough to make good substitutes for pine. The most valuable of these are:

Cedro — Cedrela Odorata L.
Tabanuco — Dacryodes excelsa Vahl.
Laurel sabino — Magnolis splendeus Urba
Guaraguao — Guarea trichilioides L.

All are large trees, that is, over 75 feet in height and three feet in diameter when mature. Best of all they form stands dense enough to log economically; 15,000 board feet per acre is not uncommon in virgin stands. In addition there are scattered hardwoods like mahogany — Swietenia mahagoni Jacq — and ausubo — Sider oxylon fœtidissimum Jacq — valuable on account of their durability and ornamental qualities to increase the productivity of this type. Unfortunately very little of the original forest is now left in this type because the land has been practically all cleared for agriculture.

The dry deciduous type is preëminently the home of the

heavy, hard woods like lignum vitæ, ebony, etc. The dry season is long, so long in fact that the trees are not able to attain large diameter or height growth. Sixty feet for the latter and two feet for the former are the maxima. Neither are the stands dense and except for the undergrowth of cacti a horse may be ridden anywhere. At the same time the following species have such valuable qualities that they are logged in spite of their short and crooked boles:

Cabinet woods.
- Lignum vitæ — Guajacum officinale L.
- Algarroba — Hymenæa courbaril L.
- Moca — Andira jamaicensis (W. W.) Urb.
- Dye wood — logwood — Hæmatoxylum campech.
- Corkwood or balsa wood. Oshroma lagopus Siv.

But highly prized as these species are they do not offer attractive logging because they never occur in pure stands but are found singly, seldom more than one to the acre of any one species. Consequently even virgin stands are low in yield, rarely exceeding 2000 board feet per acre.

Murphy's estimate of the present stand is 2,487,000 cords, or approximately one cord per acre, only half of which can be sawn into logs. Hence, it is evident that except in the most inaccessible places there is not enough timber to attract a lumberman. Nothing else can be expected when it is remembered that the rural population is denser than in any state of the Union. In fact only 2 per cent of the total land area still has virgin forests and not more than 8 per cent has saw timber. The rest of the 20 per cent is simply brushland which will yield merely firewood.

CHAPTER XX

PHILIPPINES

The Philippine Islands are one of the few reservoirs of tropical timber which have been carefully investigated. The Spanish Government had granted very few alienations so that when the United States took possession of the islands in 1898 there were 41,000 square miles of virgin forests placed under our control. Since that time the Philippine Bureau of Forestry has been systematically estimating the stands, looking for suitable logging chances and testing the different kinds of timber. Hence, there are few equal areas of tropical woodland which have been so thoroughly described. The data here presented were obtained from the publications of the Insular government and special papers in the technical journals.

The total land area in the islands of 123,000 square miles is divided as follows:

	Per cent
Tillage	10
Grassland	40
Second growth timberland	$16\frac{2}{3}$
Virgin forest	$33\frac{1}{3}$
	100

Only the virgin forest has been reported upon by the Philippine Bureau of Forestry. The second growth stands occur on areas which have reforested after being abandoned for tillage and do not contain merchantable timber in amounts large enough to repay anything but local development on a small scale.

The Bureau of Forestry has divided the virgin forest into the following forest types:

	Per cent of virgin forest area
Dipterocarp types	75
Molave type	10
Pine type	5
Mangrove type	2
Mossy (mountain) forest type	8
	100

Dipterocarp Types.— Commercially as well as in extent the dipterocarp types are the most important. The average stands per acre of valuable timber range from 2 to 45M board feet with an average of 10M. Fortunately, too, a high percentage of the stands consists of species which yield easily worked construction lumber similar in characteristics to the yellow poplar of the southern Appalachians. In fact, the determination of this important point was unique in tropical lumbering. It had been assumed heretofore that the only valuable species were the cabinet woods like mahogany, ebony, and lignum vitæ and that tropical building construction must depend upon the pines of the temperate zone for its cheap building material. Moreover, this puts an entirely different aspect on things for the lumberman. The cabinet woods do not occur in heavy stands but scattered singly so that only the crudest logging methods have been employed in their exploitation but a stand of 10M board feet per acre justifies the installation of the economical steam skidding methods developed for the heavy stands of the northwest and reduces greatly the cost per M of getting out tropical lumber.

Of all the dipterocarp types the one with the heaviest stands per acre is the lauan type on which the lauans, with wood like our yellow poplar, predominate, and in which stands of 45M per acre are not uncommon. This occurs, as might be expected, on the deep soiled sites where the rainfall is evenly distributed thruout the year and abundant, *i.e.* over 60 inches per annum. Given plenty of precipitation it may extend up to an elevation of 1000 feet above sea level where the temperature conditions become unfavorable. A good idea of the composition of the type may be obtained from the following table which is based on the measurement of over 100 acres of strip surveys:

	Per cent
Red lauan	41
Almon-lauan	20
Apitong	14
Tanguile	13
White lauan Bagtican lauan	6
Other species	6
	100

The red, almon, white and bagtican lauan and tanguile are all suitable for light and medium construction work having wood similar to that of yellow poplar and Douglas fir, hard pine. This means that they are not durable in contact with the ground or resistant to white ant attack but neither are their competitors. Nevertheless, they can fill the demand in the tropics which is now being met by importations of northern softwoods. Furthermore, the better grades are being shipped to the United States as "Philippine mahogany." Apitong, altho also a dipterocarp, is harder and heavier than the lauan group and tanguile. It is suitable for heavy construction work where it will not be in contact with the ground, and enters directly into competition with the imported hard pine.

The second dipterocarp type, the lauan hagachac type, occupies sites similar climatically to those of the lauan type but the growth conditions are less favorable because during the rainy season there is an excess of soil moisture in the bottomlands which this type preëmpts. Light construction woods like lauan and amugius make up 41 per cent of the total average stand of 16,000 board feet per acre while the heavier woods suitable for interior framing compose 25 per cent. Among the remaining 34 per cent, narra, the most common commercial wood of the Philippines and a substitute for mahogany and padouk, is the only one that deserves special mention. It makes up 5 per cent of the total stand. Summing up, 71 per cent of the total volume of this type finds a ready sale on the local markets with the export trade comparatively undeveloped as yet.

In the yacal-lauan type a smaller percentage of the total stand is readily marketable but the stands are heavier. Of the average stand of 28M feet per acre 17 per cent consists of the softer dipterocarps, 20 per cent of the harder varieties of wood suitable for interior framing but not where great durability is required, and 20 per cent of durable woods which can be used in contact with the ground and will resist white ant attacks. This type occurs on volcanic soil at low elevations where the rainfall is abundant but irregular. The dry season is often prolonged enough to cause the fall of many of the leaves so that the type is semi-deciduous.

A dry season and consequent falling of the leaves is also characteristic of the lauan-apitong type. This is, in fact, the main character which separates it from the lauan type. Otherwise, it occupies much the same sort of sites, the foothills below an elevation of 400 meters above sea level. Ordinarily, no durable woods occur in this type but 42 per cent of the average stand of 28M feet per acre are the harder dipterocarps suitable for interior framing and cabinet purposes. The soft dipterocarps compose 26 per cent of the stand.

The remaining dipterocarp type, the tanguile-oak type, has not yet been so thoroly studied as the other types because it is not so important commercially on account of its relative inaccessibility. It occupies the middle mountain slopes between the lauan and lauan-apitong types and the mossy-forest type at elevations between 400 and 900 meters above sea level. Tanguile is the important species commercially. Its wood is fairly soft but not durable so that it is mainly used for interior construction purposes.

The composition of the dipterocarp types is summed up in the following table:

COMPOSITION OF DIPTEROCARP TYPES

Types	Dipterocarps suitable for construction woods		Durable woods	Misc. species	Total stand per acre
	Soft	Hard			
	Per cent	Per cent	Per cent	Per cent	M bd. ft.
Lauan	80	15	.....	5	45
Lauan-hagachac	41	25	5	29	16
Yacal-lauan	17	20	20	43	28
Lauan-apitong	26	42	.....	32	28
Tanguile-oak		(Data	lacking)		

Molave Type.— The molave, a near relative of teak and a substitute for it, gives its name to a type which occurs on dry limestone soils where the drainage is so rapid that there is insufficient moisture for dense growth even tho the dry season is short. The type does not occur at elevations greater than 500 feet above sea level so that the temperature conditions are always tropical in

character. The great evaporation and rapid runoff produce conditions which are not favorable to either dense growth, rapid growth or great individual development. The traces are short and far apart. Commercially, however, this has been and is an important type because of its accessibility and the great demand for the hard, durable woods like molave, narra, trudalo, acle, banuyo, etc. Hence, altho the average stand under virgin conditions is only 3M per acre the type has been heavily exploited.

Mangrove Type.—Another type which has relatively low stands per acre but which has been heavily exploited by reason of its accessibility and the special value of its products is the mangrove type which fringes the shore line of protected salt waters. The trees cannot stand heavy surf but form a low dense growth in such relatively sheltered locations as the muddy flats at the mouths of the larger streams. Under virgin conditions the stand per acre has been found to run as high as 13M board feet of saw lumber altho this included a relatively small proportion of the trees. The type has been principally exploited for firewood and for tanbark and stands of five cords per acre or 10 tons of bark are not unusual. Growth is fairly rapid so that the same area may be cut over for fuel and bark at intervals of at least 20 years.

Pine Type.— Stands of pine averaging 7M per acre and made up of trees 100 feet high and 30 inches in diameter occur in the high plateau region of northern and central Luzon at elevations ranging from 3000 to 5000 feet above sea level. The climate is distinctly cooler than at sea level so that growth is fairly rapid in spite of the long dry season. Unlike many species of pine these stands can stand considerable burning and are able to hold their own against the encroachments of the grass in spite of the frequent fires.

Beach Type.— On the sandy beaches above tide water which have not been preëmpted for settlement and consequently had their original vegetation much modified there are light stands not exceeding 3M board feet per acre of such durable woods as ipil, narra, dungon, palo maria and agoho scattered among less valuable species.

Mossy Type. — Another relatively unimportant type is the dense but scrubby tree growth found on the exposed mountain summits. None of these produces in sufficient amount to pay for its exploitation.

Timber Values. — The determining factor in the methods of tropical estimating are the low values of stumpage per M and per acre. Even the valuable cabinet woods like mahogany and ebony are worth very little standing. They only become so when transported long distances to the user. As a consequence it is not worth while to estimate them closely. It is sufficient to determine that there is at least so much on a given tract. In other words, estimates of tropical timber need to be especially conservative. A wide margin of safety must be present in an enterprise which involves so many risks. By way of comparison the woodlots of New England lie at the other extreme. The manufacturing plants are close at hand and transportation never makes up more than 20 per cent of the sale value and from 50 to 25 per cent is paid for stumpage.

The problem being then to determine within 25 per cent how much timber there is on a tract relatively crude methods may be used, provided care is taken at every point to be on the safe side. Liberal allowance must be made for defect. While strips are safer, sample plots will often be good enough especially for large tracts. They should, however, be distributed in some regular manner or the tendency will be to take them in the better timber. Preferably they should be at fixed distances apart but time intervals will serve for large tracts if the rate of travel is kept uniform. For example a tract may be traversed at intervals of a mile and sample plots one-quarter acre in size taken every one-quarter mile.

The costs of such estimates will necessarily be low per acre but relatively they will be high because of the cost of travel to the tropics. There are few firms that make a specialty of estimating tropical timber and maintain local agents. Consequently it is usually necessary to send from the temperate zone a man who is sufficiently acquainted with tropical conditions to make a safe estimate. But even under these circumstances a tract of 100,000 acres ought to be valued for two cents per acre.

The same principle holds with reference to stumpage prices that applied to estimating. An ample margin must be ensured on account of the risks involved. Markets are uncertain, methods are crude and inefficient and labor unskilled in the average tropical lumbering job. For example, mahogany logs have commonly been felled with an axe, dragged overland with oxen or driven down the nearest stream. Even with cheap native labor these operations have been expensive so that there are very few mills whose logs cost less than $5 per M and many where the cost is two or three times that. Of course, the operations equipped with modern steam skidding appliances do not have to pay so much but they are the exception rather than the rule. In fact, they are only feasible in heavy stands like the dipterocarp forests of the Philippines. The logging of the better known tropical woods like mahogany, West Indian cedar, ebony, etc., is still carried on in a primitive way because the trees do not occur in dense stands but grow scattered.

Likewise, the milling is expensive for several reasons. In the first place the timber is generally hard, heavy and difficult to season. Hardwood mill costs are always greater in the states than softwood costs. In the tropics there are two other factors which need consideration. Skilled labor is hard to obtain and hold. It must be imported at great cost and the men do not find living conditions for themselves and their families which attract them. Furthermore, deterioration of the machinery and buildings is very rapid in the moist, warm climate. Tools and machines can only be kept in order by extraordinary vigilance. Hence, mill charges in the tropics must be put at least 50 per cent higher than in the states. There are in fact few mills that got sawing alone done for less than $3 per M prior to the War. Planing, kilndrying and yard charges are proportionately high.

Transportation from the mill to market is, however, the most difficult factor. This is, of course, simply another way of saying that the tropics are for the most part unequipped with cheap and rapid means of moving heavy freight. Water transport is the cheapest and it is safe to say that no sizable sawmill can be made to pay under present conditions unless it is on tidewater or

a navigable stream. Even then small steamers or sailing vessels must be relied upon which are not built specially for this kind of cargo. In the Philippines the cost varied from $5 to $30 per M, while an operation in Brazil marketing its product in Buenos Ayres had a charge of $20 per M to meet in 1915.

Sale values in the wholesale markets may be illustrated by the prices paid in Manila in 1910 when the softer, non-durable construction woods like the dipterocarps were selling for $25 to $30 per M, hard durable timbers from $75 to $100, and the cabinet woods from $80 to $150. These prices would give ample margins, especially in the case of the cabinet woods, if there were no accidents, but the two limiting factors of primitive logging methods and poor transportation to market generally cut down the average margin to less than $10 per M.

In conclusion Dr. Whitford's words (Bulletin 10, The Forests of the Philippines, Part I) may be used to give a bird's-eye view of the situation because they apply to all kinds of tropical lumbering:—

"To sum up, the high cost of placing the timber of the Philippines on the market is due to the following causes: (1) The high cost of logging, due principally to the crude methods employed and to lack of proper supervision; (2) the excessive cost of milling, due to (*a*) insufficient equipment and poor arrangement of the mill, (*b*) to the difficulty of getting competent men to manage the operations, and (*c*) to a consequent loss in sawing due to excessive waste and poorly manufactured material; (3) as yet no company has a capacity sufficient to warrant their owning or hiring vessels especially adapted to carrying lumber to the home or foreign markets. The conditions above described are distinctly pioneer in nature. A few companies have successfully met some of them, but none have as yet succeeded in meeting the entire situation. When they do, they will be able to compete with all other timbers of like grades in the foreign and home markets."

Besides the value of the Philippine forests for the production of lumber a number of other special products are obtained from them. Fuel purposes, for example, actually consume a larger

total amount of wood than lumber uses but it is nearly all for local consumption and is gathered in small amounts. The mangrove swamps being nearest to the settlements along the shores have had to furnish most of this material. Firewood was worth $12.50 a cord in Manilla in 1910.

Another important use of the mangrove swamps is for dyestuff. Tannins are also obtained from this type, the "cutch" being made from the bark. The resins for caulking, paint and illuminating purposes come from the native pines and the dipterocarps. Gutta percha and rubber can be obtained from many wild species of trees and vines and the cultivation of rubber has passed the experimental stage. Various oils useful for soap or medicinal purposes are collected for local consumption. Tying material also comes largely from the forest. Rattan is another tropical forest product which is not only used for tying large packages like bales of hemp and tobacco but is also employed for furniture and hats. But unquestionably the erect palms are the most useful of any single class of trees. Their trunks are used in building either on the round or split, the leaves make mats, roofing, etc., and the fruit is edible in several species.

What the value of these minor products is per acre for any given type of forest cannot be stated in general terms. Each case must be examined separately because of the paramount influence of local market conditions. Many of these have no value at all over wide areas under present transportation conditions.

Land Values.— In figuring the value of the land itself in the Philippines there are the same three possibilities to be considered in each case as in temperate climates, — tillage, pasturage and forestry. It must be assumed that because the climate is warm enough for a great variety of plant growth that all soil is potentially tillable. Other factors need to be considered, the most important of which are the amount of rainfall and the slope and to a lesser degree the kind of soil, whether clay, sand or gravel, and percentage of rocks in the surface layer. The common conception of the tropics as a place of ample rainfall is erroneous for the regions where the mean annual precipitation is less than

30 inches. There must be at least that much to offset the rapid evaporation and for the growing of crops without irrigation 60 inches well distributed throughout the year is a safe minimum. Consequently there are some parts of the Philippines where irrigation is the *sine qua non* of successful agriculture. Slope is the limiting factor second in importance. With the heavy downpours of rain and the open winters slopes cannot be tilled as long as in the temperate zones. As a consequence only the level lands are kept in permanent tillage and clearings made on slopes are only cultivated a few years before being allowed to revert to tree growth. The character of the soil is of importance primarily from the standpoint of its ability to hold water. The open gravels and sands are only tillable where the rainfall is over 60 inches per annum. The percentage of rocks in the upper layer is of less importance in the tropics than in temperate regions because the processes of disintegration are rapid and surface rocks quickly break down. Summing up, then, only the level clays and loams are desirable for tillage and the rainfall must be abundant or irrigation possible. Such lands near the market and extensive enough to make up large units are worth fully $100 an acre when ready for cultivation. The extent of the tillable area is a matter of prime importance because tropical agriculture is necessarily a large scale enterprise because of the remoteness of markets. Aside from the trifling local demand which is mainly met by produce from their own gardens all foodstuffs must be shipped to the temperate regions for the feeding of the dense populations there. This means that transportation is the controlling factor. Consequently there are no large plantations which do not have their own wharfs or ready access to ones where sea-going vessels may dock. Furthermore, a plantation must have its own fleet of vessels or be at the mercy of the transportation companies. In other words the tropics are no place for the small scale agriculturist. Only large concerns farming vast areas and shipping in their own bottoms have been successful.

Grazing is, as always, a low use of land and this dictum applies with special force to the tropics because there are no high class

grazing lands. A sod cannot form except on level land suited to tillage. The slopes erode as fast as the tree growth is cleared from them. This should not be understood to mean that there is not a large acreage which is being used as range in the Philippines but it is in relatively small bodies, poor in quality and deteriorating in carrying capacity. None of it is worth more than 50 cents an acre for this purpose alone.

Comparatively little is as yet known in regard to the producing value of tropical timberlands. The problem of determining the age of stands is more complicated than in temperate regions because annual rings are not formed. It becomes necessary, therefore, to depend upon records of growth. From these it would appear that the better watered soils can produce stands of merchantable saw timber in less than 50 years. Hence it follows that tree production or forestry is second to tillage as a use of land. On the steeper and more arid soils it is often the only profitable use. As a general policy it may safely be stated that a change from forestry to tillage or grazing will not be profitable in the long run unless the land can be devoted to cultivated crops.

Land Titles.— As explained above, the title to the principal forest areas in the Philippines is in the United States by direct transfer from the Spanish Government. In the few cases where timberland is in private hands a satisfactory title is hard to obtain. Accurate surveys are practically unknown and many transfers unrecorded. Then, too, the problem of undivided ownership often occurs. For example the title to a tract of land may rest in the descendants of a grantee several generations back without any attempt by the heirs to parcel the land out.

CHAPTER XXI

TIMBER VALUATION

In the determination of the value of standing timber, or stumpage value, the following four factors must be considered:

1. The amount of the timber in board feet, cubic feet, cords or other unit.
2. The quality of the timber.
3. Sale value of the finished product whether lumber, cordwood, etc.
4. The costs of manufacture including logging, milling, etc., and a reasonable profit to the logger and mill man

Estimating.— It is not necessary to discuss here in detail the various methods employed in determining the amount of standing timber. It does seem apropos, however, to summarize the facts which have been developed in the discussion of the different types of timber with reference to the costs of estimating.

The cheapest kind of an estimate is, of course, a guess and strangely enough this method is employed widely with one of our most valuable types of timberland, second growth white pine. The reasons for this are that the stands are remarkably uniform in size and density while there is but one merchantable species and the tracts are small. It is perfectly possible for an experienced operator to guess within 5 per cent of the true amount. But no man would feel safe in applying this method to large tracts which he could not walk all over in a day. Hence it happens that large tracts of cheap stumpage such as are found in the tropics must be taken as examples of the second cheap method of estimating, the sample plot method. In this way a large area can be covered expeditiously and yet sufficiently accurate results obtained. For most cases the third method — the strip system — is the best. Where the tract is large, the stand uniform and the stumpage cheap the percentage of the area actually measured may

be small while on small tracts of valuable timber, and especially in complex stands, the percentage should be high. As an illustration of the former conditions the Douglas fir type on the Pacific may be cited. The percentage estimated may run as low as 1 per cent and seldom exceeds 5 per cent. On the other hand, only high percentages will give satisfactory results in the valuable white pine of the Lake States or the mixed stands in the southern Appalachian coves. The following table summarizes the methods and percentages applicable in the different types:

		Per cent
Northern spruce	strip method	5 to 10
Northern hardwoods	"	10 to 20
White pine	"	25 to 100
Swamp	"	5 to 25
Southern hardwoods	"	5 to 100
Bottomlands	"	5 to 10
Southern pine	"	5 to 10
Western yellow pine	"	5 to 10
Lodgepole pine	"	5
Engelmann spruce	"	5 to 10
Silver pine	"	10
Sugar pine	"	10 to 20
Douglas fir	"	5 to 10
Sequoia	"	10
Alaska	"	1 to 5
Tropics	strip or sample plot	1 to 5

Wages and food costs vary in general directly with the accessibility. A man demands more to go into the wilderness and his food costs more than when he is working near settlements.

The accessibility is also the most important factor in base line and corner location. The longer a region has been settled the better the surveys are in most cases. Unfortunately, this rule does not hold for most of the thirteen original states. The southeastern Atlantic states are notorious for their confused and overlapping land grants, while many of the newly settled western states have fairly good surveys to tie to, thanks to the rectangular land survey system.

The size of the trees, their number per acre and their variety are also factors which affect the cost of estimating. Medium sized trees are the easiest to estimate closely while the stands with

a great range in diameter and height require constant checking to prevent errors. It is, of course, axiomatic that more time is required to cover dense stands than open stands. Likewise, a large number of different species slows down the estimator. Estimating in the mixed stands of the Southern Appalachians takes more time than estimating in pure stands of white pine other things being equal.

The following table summarizes estimating costs including the necessary office work in the different regions and offers a chance for a comparison of the amounts required under various conditions:

Type of timber	Per cent covered	Minimum cost per acre
		Cents
Spruce	10	15
Northern hardwoods	10	10
White pine	10	10
Northern swamp	10	10
Southern hardwoods	25	45
Cove	10	10 (average 5)
Slope		
Ridge	5	3
Bottomlands	10	15
Southern pine	10	7½
Western yellow pine	10	4
Lodgepole pine	5	10
Engelmann spruce	10	15
Silver pine	10	10
Sugar pine	10	10
Douglas fir	5	6
Redwood	10	10
Alaska: Hemlock-spruce	5	7
Alaska: Spruce-birch	5	7
Tropics	1¼	2

Minimum costs are given because average figures would be of little value without some knowledge of the range and the upper limits are exceedingly variable. In fact the main use of the table is to show the relative costs. For example, costs are ordinarily lowest — two cents to four cents an acre — in such widely separated regions as the western yellow pine type of the Rocky Mountains and the tropics. In the case of the latter the low percentage estimated is sufficient to account for the low cost while the uniformity of the stands, freedom from underbrush and low value

of the timber explain why western yellow pine can be estimated cheaply. The timber of Alaska also falls into this group.

In the next group — that in which the cost per acre is seldom less than five cents — are types from various parts of the United States. They have the same minimum cost for various reasons. The lodgepole pine of the Rocky Mountains occurs in dense stands of uniform size, not readily accessible and hence not especially valuable. Silver pine stands on the other hand are valuable but they are so uniform in size and composition that they can be covered rapidly. The costs for southern hardwoods are also low in spite of the variety of species because of the low stumpage values and openness of the stands. This statement is true even tho the southern hardwood coves contain dense stands of valuable species for the reason that the coves form but a small percentage of the type.

In the seven to eight cent group fall the open stands but high priced stumpage of the southern pine type; the dense, inaccessible Engelmann spruce, and the heavy but low priced stands of Douglas fir, redwood and sugar pine.

Northern hardwoods and northeastern white pine cost about the same per acre because the stumpage values are high. The greater value of the pine offsets the larger number of species in the hardwood type.

The most expensive types to estimate are northern spruce and the southern bottomlands. Both have relatively valuable stumpage and both are inaccessible with poorly marked boundary lines.

Quality of Timber. — Of the factors that effect the quality of timber, size is the most important. Other things being equal the wider and longer a stick of lumber is the more valuable it is. The largest sizes can naturally be secured from the Pacific Coast where the climatic conditions have favored the growth of large, tall trees of unusual dimensions, so that the sequoias, Douglas fir, sugar pine, silver pine or western larch are sought when exceptionally wide or long lumber is needed. The east can, however, give lumber of no small size from its white pine, southern yellow pine and yellow poplar. In fact, these species grow large enough

for common uses and it is the practice to cut down to normal size most of the western coast lumber put on the market.

The other types of timberland not listed above produce medium sized trees with the exception of considerable spruce and lodgepole pine which comes on the market in small sizes.

Technical defects vary with the use to which the trees are to be put and the species. For example, less than 10 per cent of the average eastern red spruce tree could be used for airplane stock because only clear, straight grained wood would meet the requirements. On the other hand at least 60 per cent of a tree of the same species can be used for pulpwood. Hence it is always necessary in estimating the value of a tract of timber to be armed with a full knowledge of the uses to which the trees are to be put and what technical defects preclude them from such use. This means that the estimator must know exactly what effect knots, spiral grain, and color of sapwood or heartwood have on the sale value of the species being valued.

Closely related to the deductions for technical defects are allowances made for damage from fire, insects, fungi, wind, snowbreak, noxious gases, etc. They are in fact determined in the same way, by a close study of the cull made at the sawmill or manufacturing plant. Usually it is not necessary or possible to separate the effects of the different kinds of damage. Simply a lump estimate of cull is sufficient. This may run from 60 per cent of the log in the case of high grade quartered stock to less than 2 per cent in the case of boxboards. It must always be determined locally because use possibilities, amount and degree of damage vary from tract to tract.

The ideal to be attained in any logging operation is the most complete utilization that market conditions will permit. This should take into consideration not only the logs fit for lumber but the whole tree. By volume an average tree is made up as follows:

	Softwood	Hardwood
	Per cent	Per cent
Stump	5	5
Bole	60	45
Limbs	15	20
Branches	10	15
Bark	10	15
	100	100

It is readily seen that an operation which only takes out the butt logs is utilizing a very small per cent of the whole tree. This often falls as low as 30 per cent where transportation is expensive. Reports on the value of a tract of timber should always take this factor into consideration. It may well happen that a tract only capable of turning out low grade lumber, posts and cordwood may yield much more per acre, gross and net, than a tract of high quality timber on which market conditions do not permit close utilization.

Sale Values.— The per cent of utilization is also a very important factor in determining sale values per acre because a high value per M may give no real notion of the returns to be expected from a tract if only a small portion of the tree can be gotten to the sawmill. In this discussion the value per acre will, therefore, be taken as the criterion altho lumbermen are more accustomed to think in terms of a thousand board feet than in terms of acres. In other words the point of view assumed is that of the man who wants to know how much a given tract will yield him rather than that of the operator who is interested in turning out a certain product.

However, the determination of the sale value per M is, of course, the first step in figuring sale values per acre. A list is therefore given of these values for the important species at their nearest market point. These points must necessarily vary because there is no central market in which all kinds of lumber compete on an equal footing. Western fir, for example, only reaches the Atlantic Coast in the best grades while the lower grades are widely used locally. Further it must be remembered that the values given are averages for the log run. Grades can-

not be compared directly because they are intended to fill the requirements of special uses to which other species may not be suited at all. But in reaching the average values per M, log run, the percentage of the different grades and their respective sale values must be considered. This introduces a serious difficulty because these percentages vary within wide limits. Furthermore, the prices per M of the different grades are subject to fluctuations. Consequently it is impossible to give even for a specified date absolutely accurate figures. All that can be hoped is that the figures are relatively correct.

The first table is a list of wholesale values by use classes. These prices are intended to represent the values at which retail yards may purchase from the mills that do their own marketing or from wholesalers handling the product of several mills. They give for the principal classes of wood products the prices that obtain for lumber, cordwood, etc., designed for a certain purpose irrespective of species. Boston was chosen because it is a market close to the manufacturing centers and its prices represent maximum values. A fairer comparison of relative values can be secured in this way than if a market were selected which is not equally favorable to all kinds of wood.

WHOLESALE VALUES PER M FOR THE PRINCIPAL USE GRADES OF WOOD PRODUCTS

Based on Boston prices, Jan. 1, 1920

	Per M
Lumber:	
Tropical cabinet woods	$250
Quarter sawn oak	250
Clear, extra wide softwood	200
Native cabinet woods like black walnut	200
Ash (clear stock)	150
Hickory (clear stock)	125
Hardwood finish	125
Hardwood flooring	100
Softwood dimension	60
Softwood inch boards	45
Boxboards	35
Shingles	40
Laths	50

Cordwood:	
Best hardwood $12 per cord	24
Softwood $7.50 per cord	15
Poles	50
Ties	30
Cooperage (tight and slack)	50
Pulp	20
Tanbark	10

The next step is to use these figures in determining the values per M by species. Two considerations enter into this problem. It is necessary to know not only to what uses each species can be put but also what are the best uses for each part of the tree. To illustrate the first point the difference between cottonwood and curly maple may be cited. The former is wholly unfit for cabinet wood. A recent example, fresh in everyone's mind, of the second point is airplane spruce. Material that will meet the rigorous specifications of the airplane manufacturer can only be secured from the butt logs of the larger trees. The upper logs are wholly unfit for this purpose.

Taking up the use classes in order, the first may be quickly disposed of because tropical cabinet woods come only from the Philippines and to a very limited extent from Porto Rico, Panama and southern Florida. Mahogany and Spanish cedar are the most important species but only a very small proportion of the whole tree reaches the market. While there are no exact data it seems safe to say that not more than one-third of the whole tree reaches the market. In the first place only relatively clear, sound lumber can be used while poor transportation facilities make it desirable to leave in the woods all non-merchantable material. Consequently while the prices of merchantable tropical cabinet woods are high, the value per M of what would be salable with most tree species is low. With one-third of the tree reaching the market and a value per M of $150, the sale value judged by the ordinary standards of merchantability is reduced to $50 per M. Quarter sawn oak is exactly the same kind of a proposition — high prices for a small selected portion of the whole merchantable part of the tree judged by the standards of merchantibility applied to other species.

Extra wide, clear softwood presents a different problem for while merely a small percentage of the tree gives lumber which can be included in this use class the rest of the tree is not wasted. As an example of the kinds of lumber obtainable, the sugar pine figures of Larsen's Bulletin No. 426 of the U. S. Forest Service may be cited. Converting lumber grades into use classes gives the following percentages:

	Per cent
Wide clear lumber (firsts and seconds)	15
Sound lumber with small knots, "dimension" or "shop"	30
Timber with large knots only suitable for cutting up, "common" and "boxboard" grades	55
	100

The only other kinds of softwoods which would have as high a percentage of wide, clear stock are cypress, virgin white pine, silver pine, yellow poplar, and redwood. Basswood, cottonwood, and yellow pine seldom average better than 10 per cent while Douglas fir and spruce cannot be depended upon for more than 5 per cent.

Of the native cabinet woods black walnut stands in a class by itself but like the tropical cabinet woods only a small proportion of the tree is ordinarily used. Fifty per cent would be a generous estimate even when the narrow strips used for gun stocks were to be cut.

Ash and hickory are not used for the same purpose but their utilization is similar in method. While each possesses a special field in which it distances all competitors, only clear, sound stock can be used. This in turn means much waste judged by the ordinary standards of merchantability.

Hardwood finish and flooring can be conveniently grouped because they are both made from narrow, clear lumber. While flooring is seldom over four inches wide the maximum width for No. 1 absolutely clear finish is six inches, so that there is no great difference in this regard. Braniff's figures in U. S. Forest Service Bulletin 73 furnish the best indication of what may be expected from hardwood timber as far as high grade stock is concerned. He found that not more than 30 per cent of a lot of large, sound

logs would give No. 1 and 2 grade which may have a limited number of defects if more than 6 inches wide. The remaining 70 per cent of the log was only fit for common lumber from which no clear stuff was obtainable except in short lengths and narrow widths. Consequently finish and flooring do not give close utilization or high net returns.

Softwood dimension lumber is really the first group which uses a reasonably large proportion of the log. Thirty per cent is the figure for sugar pine while species like Douglas fir and spruce which have very little clear lumber naturally give larger percentages if "dimension" or "shop" lumber. Both these grades are essentially the same. Soundness is the desideratum. If the species has stiff wood like spruce, dimension is the best use. If it is weak like pine it is graded as "shop" and cut up for door or sash stock.

It is not, however, until the common inch board is reached that the greater part of a log can be thrown into one use class. "Common" and "boxboards" are the grade names for the knotty lumber which comes from small and top logs and the inside of large logs. Even in such a large species as sugar pine 55 per cent of the average log must go into these grades. Small logs like those of second growth pine yield nothing else. Both hardwood and softwood "common" lumber go mostly into boxes and crates.

Summing up, the grades of lumber which can be obtained from the average log are as follows:

	Per cent
Softwood lumber:	
Clear, wide stock	15
"Dimension" or "shop"	30
Common and boxboards	55
	100

	Per cent
Hardwood lumber:	
Finish or flooring	30
Common boards	70
	100

Ordinary sawn shingles utilize the same parts of a tree that lumber does. The only difference is that a higher per cent is manufactured than with square edge lumber because there is less waste in slabs and edgings. Shingles sell for $25 to $35 per M board feet, log scale.

Laths furnish the only outlet for the sale of the slabs and edgings in the ordinary sawmill and even they cannot be manufactured at a profit where there is a long freight haul to market. Reduced to board feet laths sell for about $20 per M (1920).

So far only that 30 to 50 per cent of the solid cubic contents of the tree has been considered which is in the bole.

Little attention need be paid the stump because it is only rarely merchantable and then at a low figure. This does not, however, apply in the case of the limbs which may be made to yield much valuable pulpwood, extract wood or firewood. All tree species may be cut for the latter purpose but there is a wide difference in their fuel value. A cord of pine will not give more than half the heat that a cord of hickory will. Distance to market is the controlling factor, however, since cordwood is bulky, heavy material which is not valuable enough to repay shipping far. In the ordinary logging job it must be left in the woods. But where the haul is not too great the cordwood may add $1 to $5 to the profit on each thousand feet of lumber.

Similar returns may be expected from pulpwood, extract wood and wood alcohol in favorable localities. Yellow poplar is the most commonly used limb wood for the former while chestnut is the only species widely used for extract wood. Beech, birch and maple are most sought in the manufacture of wood alcohol.

Poles are one of the few uses which utilize a high per cent of the tree. In addition to all that could be turned into lumber much that would otherwise be only fit for cordwood is taken. Unfortunately, relatively few species have sufficient durability in contact with the ground to be suitable for this purpose. Hence, 90 per cent of all poles used in the United States are either cedar, chestnut or oak.

Railway ties also make use of parts of the tree that are ordinarily considered too coarse for lumber so that the utilization is

midway between that of lumber alone and lumber and cordwood combined. Durability is of the first importance here as with poles while hardness is scarcely less important. The species commonly used for poles are also those most sought for railway ties

For tight staves only a few species are suitable and oak, white and red, is the most desirable. In fact more than four fifths of all tight staves are of oak while whiskey and beer casks are made from white oak only. Moreover, these uses demand clear lumber so that they are not close in their utilization. Slack staves, on the other hand, can be made from medium grade lumber from a number of species and from small logs so that they utilize about 60 per cent of the total cubic contents of the average tree.

Summarizing the utilization obtainable with the various uses referred to above gives the following figures:

	Per cent of the whole tree
Clear wide softwood	5 to 10
Clear hardwood	15
Dimension or shop lumber	15
Common boards	35
Shingles	60
Laths	10
Cordwood	20 to 80
Poles	70
Ties	20 to 70
Cooperage, tight	15
Pulp	20 to 80
Tanbark (usually in addition to other uses)	

Having discussed the sale values of the various kinds of wood products and the per cent of each which can be obtained from the different commercial tree species, the two may be combined to give average sale values per M for each species. These differ from the Forest Service log run average prices f.o.b. mill in two important respects. In the first place, the table given below takes into consideration the use of wood for other purposes than lumber. Tops and bark are included wherever merchantable. Secondly, the values are wholesale prices in a recognized market, not values f.o.b. the producing point to which uncertain freight

rates must be added to make it possible to compare them intelligently. The Forest Service figures were, of course, used as a check.

Two objections may be validly made against these figures. They are, in the first place, merely for one market. Other markets may vary greatly in their prices for a given product. While it is obviously impossible to deny this criticism, it is equally out of the question to correct it by giving in the limited space available data for all the wood markets. Even a selection of the most important would be difficult to decide upon and not especially helpful. The prime use of the figures is for purposes of comparison. No work of this kind could be expected to be revised frequently enough to keep up to date with daily market changes. The second objection is that the values given are more nearly maximum than average. Minimum prices would be of no use because there is no lower limit beyond which the necessities of a seller may not force him. If he must sell current market quotations merely represent an unattainable maximum. Since there is, therefore, no absolute minimum maximum prices are the only ones that can be secured in sufficient abundance to prevent gross errors. They are the prices sellers like to give out. They are published in all trade journals while figures of actual transactions are guarded jealously.

Much the same conditions prevail in the choice of uses to which wood may be put. High grade mahogany is frequently used in the tropics for firewood or railway ties, but such uses do not interest the woodland owner. He wants to know how he may get the most out of his timber. Therefore, it has been assumed in figuring the average values that each part of the tree is put to its highest use.

The tree species which have been discussed so far fall into three groups when arranged according to their values per M with all parts of the tree included. This grouping may appear strange at the first glance unless it is remembered that all the merchantable parts of a tree are considered, tops and bark as well as those portions which will make lumber. The importance of such figures is easily apparent to the woodland owner who plans on

producing continuous crops of timber. What he wants to know is what will bring him the most per acre. In other words, his point of view is different from that of the lumberman who thinks only in terms of logs. In fact the acreage, and not the log, basis seems the reasonable attitude for all timberland owners to take irrespective of whether they are going to raise continuous crops. In purchasing or operating a tract the owner is anxious to get a large net yield per unit area irrespective of whether it comes from choice logs or branchwood. Like the meat packer the timber-owner can no longer afford to neglect his by-products.

Wholesale values per M feet board measure in timber and supplementary products at mill, January 1, 1920.

Group I. Values of $50 per M and more.

A. Cabinet and furniture woods with merchantable tops.
Yellow poplar, walnut, white and red oak, maple, birch, and black cherry.

B. Wide, clear softwoods, tops not merchantable.
Virgin white pine, silver pine, sugar pine, and redwood.

C. Softwood valuable for interior finish and dimension stock, tops usually merchantable.
Southern yellow pine.

D. Special hardwoods, tops merchantable.
Ash and hickory.

Group II. Values of $40 per M and more.

A. Second grade hardwoods, tops usually not merchantable.
Chestnut, black oak, basswood, red gum, cottonwood and tupelo, beech.

B. Softwoods mostly used for dimension timber.
Cypress, western yellow pine, western larch, spruce, and Douglas fir.

C. Shingle woods.
White cedar and western red cedar.

D. Pencil and chest wood — eastern red cedar.

Group III. Values of $25 per M and more

A. Low grade softwoods.

Hemlock and balsam.

B. Tropical hardwoods.

Mahogany, ebony, etc.

With this table of values for the individual species and figures for stand per acre for each type it is possible to figure comparative gross values per acre by types. As with the other tables of the same kind the absolute values per acre are not as useful as a comparison of the values. To bring out more clearly this essential feature, the relative returns which can reasonably be expected, the types are arranged in descending order.

GROSS RETURNS PER ACRE OF THE FOREST TYPES IN THE UNITED STATES AND ITS POSSESSIONS

	Per acre
Douglas fir	$2400
Virgin white pine	2250
Hemlock-spruce (Alaska)	1800
Cove (Appalachian Mts.)	1800
Bottomlands	1800
Redwood	1575
Silver pine	1350
Spruce, northern	1000
Northern hardwoods	1000
Slope (Appalachian Mts.)	1000
Southern pine	1000
Second growth white pine	800
Engelmann spruce	800
Lodgepole pine	600
Northern swamp	400
Wet hardwoods	375
Western yellow pine	315
Sugar pine	315
Ridge (Appalachian Mts.)	225
Spruce-birch	200
Dry hardwoods	75

No discussion of sale values is complete without some reference to the future trend of prices. In this field of prophecy absolute accuracy is, of course, out of the question but an examination of the past history of wood prices should give a sound basis for pre-

dicting the probable trend. On account of the lack of data for other products, attention will be wholly confined to lumber prices. Fig. 2 shows graphically the course of prices from 1860 to 1918 in the United States. These were prepared in the main by Compton by computing the average prices of the important grades and species of lumber and weighting the various species. "Organization of the Lumber Industry," Wilson Compton, 1916. The figures for 1915 to 1918 were secured from the War Industries report on Prices of Lumber by R. C. Bryant. The following species are included:

1860–1865 White pine, spruce, oak and hemlock.
1865–1887 Southern pine added.
1887–1896 Douglas fir and redwood added.
1896–1910 North Carolina pine and cypress added.
1910–1912 Maple added.
1912–1914 Yellow poplar and western red cedar added.
1914–1918 Eastern white pine, eastern hemlock, spruce, southern yellow pine, plain oak, Douglas fir, hard maple, gum, chestnut, birch, yellow poplar, ash and hickory.

The base price, 100, is the average price for the 36 months, 1901–1903. Relative prices are used rather than absolute prices to eliminate possible errors in quotations. In many cases it is difficult if not impossible to determine the exact sale value of any particular grade so that the trade journals from which the data for the curve has been obtained are liable to make minor errors in this way.

While the curve shows a general upward tendency there are many small depressions and two periods during which lumber went back to prices nearly as low as those obtained before the Civil War. The first of these, from 1875 to 1880, marked the opening up of the Lake States region. Prior to that the industries of the country had depended mainly upon lumber cut in New England, New York, and Pennsylvania. But the depletion of these sources of supply was offset in large measure by the development of railroad transporation from the Lake States to

the Atlantic seaboard. This made it possible to market cheaply the splendid white pine of Michigan, Wisconsin, and Minnesota

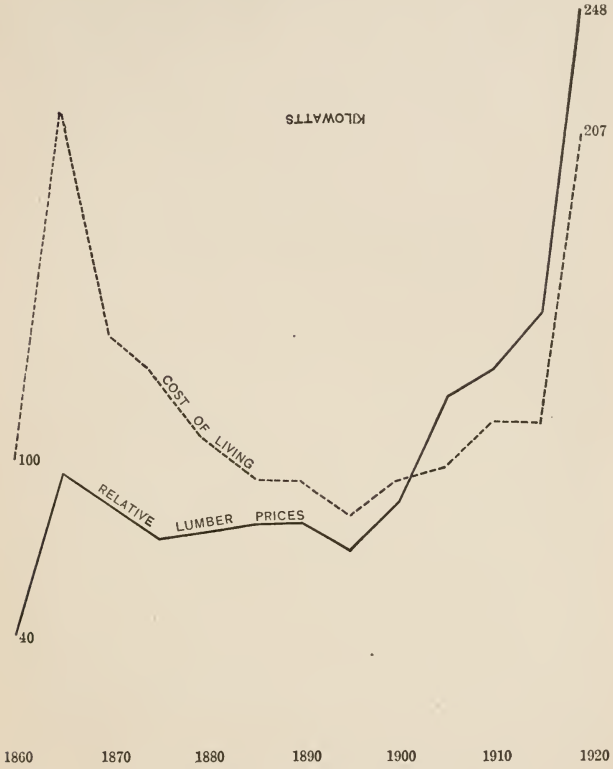

Fig. 13. The Cost of Living and Lumber Prices 1860–1920

so rapidly that the market was glutted. From the bottom of this depression in 1879 there was a gradual rise until 1883 as it became more and more apparent that the Lake States white pine was not inexhaustible. In fact the increasing cost of buying and logging led to the development of the southern pine region which in turn

flooded the market with lumber brought and logged so cheaply that it could compete successfully with that from the northeast and Lake States in spite of higher freight rates. Then the price went down again. Another low level was reached in 1896. The Spanish War in 1898 upset the usual course of prices somewhat but history bade fair to repeat itself as the northwest began to supplant the southeast as the principal lumber producing center. There was in fact a decided drop in lumber prices after 1907. This followed the tremendous expansion in the northwest and was largely the direct result of the attempt to market lumber too rapidly in order to meet carrying charges on mill equipment and stumpage. By 1912 a slow recovery had been made followed by a depression which reached its lowest point in 1914 when lumber prices were back at the 1905 level.

The effect of the Great War was almost immediate. Prices commenced to advance even before the United States declared war against Germany in spite of the impossibility of shipping lumber abroad with the submarine campaign in full swing. The demand from American manufacturers busy with war orders was, however, sufficient to absorb all the lumber that was not needed for ordinary business.

With the addition of the United States to the belligerents a new set of factors influenced lumber prices. It was immediately evident that the Government would need large supplies of lumber in the raw form for ships, warehouses, and cantonments and also indirectly for such manufactured articles as wagons, airplanes, gunstocks and boxes; hence, the necessity for centralized control of prices. This was effected by coöperation between the Government and the lumber industry and took the following forms:

1. Standardizing and centralizing.
   Government purchases.
2. Price fixing.
3. Restriction in use for non-essential purposes.
4. Restrictions on imports and exports.

Obviously the first thing to do where the Government was in the market for large amounts of lumber was to standardize the re-

quirements of the different departments so that the utmost economy could be practiced in meeting their specifications. There was no reason, for example, why the War Department should have a different requirement for ammunition box material from that enforced by the Navy. Furthermore, it was equally apparent that these and other Departments should be kept from bidding against each other. Great economies in money and time were effected in this way.

But it was soon clear that the Govenment needs were so great that some control of prices was necessary. Thru a subcommittee of the Raw Materials Division of the Council of National Defense emergency bureaus were established in the principal lumber producing centers. Besides acting as a distributing agency in placing government orders these bureaus aided materially in furnishing data upon which to fix reasonable prices. The aim was to set values which would ensure rapid and continuous production without disproportionate cost to the Government. To reach such a decision naturally entailed much research into actual costs of production and a thoro knowledge of marketing methods.

The elimination of non-essential industries was accomplished in various ways. Appeals to the patriotism of both producers and consumers did much. Actual division of raw material was also an active force in curtailment. But by far the most effective agency in securing this end was the drafting of employees from such industries while those in the so-called " essential industries " were exempt from the draft. Restrictions on imports still further curtailed the supply of raw material for the manufactures that did not contribute directly to the winning of the War while demand for their products was restricted by refusing export licenses. But in spite of the large measure of coöperation between the Government and the lumbermen who were patriotic it was necessary to markedly increase prices to keep up production to a satisfactory basis. Between 1914 and the signing of the Armistice average lumber prices rose approximately 90 per cent. The major portion of this rise took place during 1917 and 1918 when the United States was a belligerent. Lest, however, it should be assumed that this was a disproportionate rise it should

be remembered that most articles necessary to the prosecution of the War rose even more rapidly than lumber. Balson (Economics of the Lumber Industry, U. S. Department of Labor, 1919) found, for example, that more lumber could be bought with a dollar in 1919 than farm products as compared with 1914. Farm products advanced during the War so that a dollar would only buy 46 cents' worth while 58 cents' worth of lumber could be purchased for the same amount.

In fact the slowness with which lumber advanced during the War was one of the reasons why there was an advance immediately after the removal of war restrictions. Other factors which gave impetus to this upward tendency were subnormal supplies of logs, no surplus of lumber at the mills, short stocks of lumber in the retail yards, and inability of the railroads to handle shipments rapidly with depreciated rolling stock and inefficient labor. Although the country had responded nobly to all war demands it must be remembered that all efforts had been concentrated on the production of war material. Other supplies were neglected. Repairs on buildings were postponed. Every energy was directed with feverish intensity toward the German overthrow. The reaction after the Armistice was sudden and complete. It was only slowly that the routine of peace was resumed. But lumber was in great demand almost immediately to meet the need for accumulated repairs and to make up for the home building which had been abandoned during the War. This demand found all departments of the lumber business short on raw material with employees loathe to turn at once from fighting Germans to felling trees. Added to our own needs were those of our Allies. France and Belgium were in especial need of lumber for reconstruction and drew on us for hardwoods in large quantities. The price of oak and ash jumped at once, with other hardwoods following sympathetically. To show the exact effect of this in a few concrete cases take oak, ash and maple in the Boston wholesale market. Below are given the prices per M at the end of 1915, 1918, and 1919 with the rise in per cent for each year after 1915:

	Plain white oak	Maple	Ash
1915	$60	$40	$55
1918	80–33⅓%	70– 75%	115–109%
1919	160–166%	116–190%	150–172%

There has not been, however, any such marked advance in the average price of lumber. The hardwoods make up only about 25 per cent of the total lumber cut. The advance in softwoods has been much less on the whole. Spruce frames, one of the most used grades of eastern lumber, increased 116 per cent. To get a true notion of how this compares with other prices it should be compared with advances of 92 per cent in food and 135 per cent in clothing (National Industrial Conference Board Report, 1920).

To sum up the situation at the beginning of 1920, lumber was in great demand with stocks low, labor in the woods and sawmills subnormal and distribution hampered by railroad depreciation. What are the prospects in the future? The factors that tend to keep prices up are as follows:

Low stocks at the mills and retail yards.
Shortage of dwelling houses.
Accumulated repair work.
Depreciated rolling stock and lowered efficiency of railways which prevent normal delivery.
Demand from Europe for reconstruction material.
Diminishing supply of accessible stumpage.
General inflation of currency.
Low productivity of labor.

Over against these influences are such depressing factors as:

Increasing substitution.
Decrease of exports on account of unfavorable exchange rates and rehabilitation of lumber business in Russia and Austria.
Development of waterways to relieve the strain on the railroads.

Economic pressure on timberland holders to meet carrying charges by cutting even at a low profit.

Increased productivity of labor.

Deflation of currency.

Striking a balance between these two sets of factors is difficult. It involves forecasting the probable course of prices after the greatest war in history with the world facing a timber famine due to overcutting in the past. Stumpage prices seem bound to go up. The cost of production in Europe is $10 to $15 per M for softwoods and $20 to $30 for hardwoods. These seem to be what the United States will have to come to. The softwood stumpage prices have already been attained in the northeast. Lumber prices are a different problem. They need not necessarily go up along with stumpage prices. In fact European prewar prices would indicate that increased efficiency of manufacture and distribution may keep them from going much higher than they are now. Certainly there is every prospect of a temporary falling off when the peak of general commodity prices is reached. But on the other hand the times are apparently past when softwood lumber of even medium grade can be purchased for less than $50 per M or clear hardwood for less than $100.

Logging Costs for Lumber. — The difficult and complex subject of logging and milling costs must necessarily be considered briefly, at least, because a knowledge of stumpage prices is a prime essential in determining timber values. Stumpage prices in turn are dependent upon the difference between sale values and costs. Needless to say the subject is so complex that a full discussion of the various phases must be left to such special treatises as Bryant's "Logging." What is needed here is merely a bird's-eye view and a comparative notion of costs under different topographic and forest type conditions.

Since lumber is the most important single product of the forest its manufacture will be considered in detail. For other products like cordwood, tanbark, poles, etc., it will be sufficient to merely point out the ways in which their handling differs from that of lumber.

Briefly, then, all lumber goes thru the following four steps in passing from tree form to finished board:

1. Felling and bucking.
2. Skidding.
3. Hauling or driving.
4. Milling, including seasoning.

In some operations numbers two and three are combined as, for example, in the New England portable sawmill type of logging but these four steps are in general typical of the average logging operation the country over.

Felling and bucking are commonly considered together because it is usual to have the same crew do both, tho here, again, usage varies in the different parts of the country. The simplest form is a two-man crew who notch, fell, buck, bump, and pile brush all as one operation and their methods will exemplify the principles. The first step in felling a tree is notching it so that it will fall where it will do the least damage to itself and the young timber to be left standing. Since this is an operation which demands considerable skill and judgment it is usually done by the more experienced member of the crew. It is not, however, a task which takes much time. Ordinarily 10 to 15 per cent of the total time per M is used. The actual sawing off from the stump after the tree has been notched with an axe takes double the time. But what determines the cost per M more than any other item is the time required to saw the felled tree into logs or "bucking." This usually requires one-half to two-thirds of the time and explains why the cost of felling and bucking varies directly with the size of the timber. In other words, the larger the trees the less the cost per M. To illustrate this by examples at the two extremes, the cost of this step on the Pacific Coast in the heavy stands of redwood and Douglas fir has been 50 cents per M while in the second growth stands of New England the usual contract price was $1.50 per M before the War. Expressed in man hours the costs are one and one-half and three man hours per M respectively, or expressed in another way, two men in the Douglas fir region will fell and buck 10 M in a day as against four to five M in the northeast

Brush disposal so as to reduce the fire hazard and prevent smothering volunteer young growth is not a universal practice but it requires in softwoods not more than 20 per cent of the total time.

There is a vast deal of difference between the cost of felling hardwoods and softwoods. The latter cut very much more rapidly. Hardwoods may, in fact, require three times as long in small logs. Ashe states (Cost of Logging Large and Small Timber, Forestry Quarterly, XIV–3) that "the cost of felling oak, with which are included birch, beech, maple, and other species of heavy wood, is shown to be about 20 per cent greater than the cost of felling the lighter and softer woods such as white pine, yellow pine, poplar and basswood." This refers to relatively large timber.

Applying the facts brought out here to forest types they fall into several groups. In the first are the large softwoods like:

Redwood and sequoia.
Sugar pine.
Douglas fir.
Western red cedar.

With these the cost of felling and bucking has always been less than $1 per M, *i.e.*, the daily output for two men would exceed 8M or in man hours the cost per M ranges from one and one-half to two. The second group includes the medium sized softwoods such as are found in the:

Silver pine type.
Western yellow pine type.
Hemlock spruce type.
Yellow poplar cove.
Cypress bottoms.

In these stands the costs have ranged from $1 to $1.25 per M or two to three man hours per M. This would reduce the daily output for a two man crew to an average of eight M.

The small softwoods, like

Eastern spruce,
Engelmann spruce,
Lodgepole pine,
Alaskan spruce,
White cedar,
Second growth white pine,

require so much bucking to get a M feet of logs that the average cost has been $1.50 per M or three to four man hours per M giving an output of about five M per day. The hardwoods — north and south — make up the last group with costs ranging before the War from $1.50 to $2.50 depending upon the size of the trees. This means that two men can only cut three to four M per day and that the cost in man hours is not less than five.

The operation of gathering together the felled and sawn logs so that they may be economically transported to the sawmill is variously known as skidding or yarding. In northern New England "yarding" includes felling and bucking as well as skidding. "Skooting" is the term applied to this operation in the northeastern portable sawmill region but it is combined with the next step, hauling, for the reason that the stands are so heavy and the distances to the mill so short that it does not pay to bunch the logs before hauling them.

Various methods of skidding are employed. The simplest is with a single horse. One end of the log is made fast to and the horse simply pulls it out to the yard or skidway where a pile is built up in such a way that the logs can be rolled onto the wagon or sled handily. Large logs require two or more horses. In the early days before the advent of steam skidders several pairs of oxen were required to haul the large logs of the northwest, but this method was quickly replaced by steam when the power skidder evolved to the point of practicable operation. Now it is used in all operations where the logs are large and the stands heavy. Naturally, however, it requires a large initial investment and cannot be applied except where the stands are dense enough per acre to justify such an expenditure.

The main factor in determining the cost of skidding is the distance skidded. This in turn depends upon the stand per acre because it is naturally easier to get a reasonable sized pile where the stand is heavy than where the stand is thin and the logs have to be hauled long distances. Second in importance to the time required to skid the log is the time taken on the return trip. This may exceed the time consumed on the way to the skidway when logs are hauled off a steep hillside where the horses have to toil slowly back up again. Fastening onto the log and unfastening are items of minor importance.

Since then the factors which determine the cost of skidding are primarily the time consumed going and coming the lowest costs must be where these times make up the smallest per cent of the total time. Heavy stands of large logs are the first prerequisite and fast motive power the second. Consequently the types in which the lowest cost of skidding is found are the dense stands of conifers — redwood, Douglas fir, western red cedar — in the Pacific northwest and the cypress of the southern bottomlands where steam skidders are used. Costs have run in such stands from 50 cents to $2 per M.

With the other softwoods $2 per M has been the standard price. Even variation in the number of logs per M and different methods, bare ground, bobsleds, skoots, or big wheels, have produced little deviation.

Hardwoods on the other hand cost considerably more. They are heavier and more crooked. Costs have ranged from $2.50 to $3.50 per M.

Summarizing skidding costs, the forest types fall into three main groups as follows:

I. Costs ranging from 50 cents to $2 per M or about three man hours per M plus interest and depreciation charges on the machinery.

Steam skidders used. Large logs. Soft, light woods.

Redwood.
Douglas fir.
Western red cedar.
Sugar pine.

Cypress.
Southern pine (to some extent).
Hemlock-spruce.

II. Costs ranging from $1.50 to $2.50 per M or three to four man hours and four to five horse hours per M.

Various methods employed. Medium sized logs. Soft, light woods.

Southern pine.
Virgin white pine.
Western yellow pine.
Silver pine.
Yellow poplar cove.
Hemlock.
Eastern and western spruce.
Lodgepole pine.
Second growth white pine.

III. Costs ranging from $2.50 to $3.50 per M or four and one-half to five man hours and six horse hours per M.

Various methods employed. Hard, heavy woods.

Northern hardwoods.
Southern hardwoods.
Tropical hardwoods.

The third step in the typical lumbering operation, hauling, is similar in principle to skidding. The time going and coming is what determines the cost. But naturally, since distances ranging from 1 mile to 20 are involved greater care is taken to provide an easy running conveyance and a smooth hauling surface.

The simplest and cheapest method of log transport is driving. Starting from the mere rolling of logs into a deep channel it has developed into a highly specialized business with elaborate sets of reservoirs, splash dams, channel improvements, bank reinforcements, miles of booms and various ways of rafting across still water. Comparatively small streams are now successfully driven. A standard figure in the northeast where the conditions have been very favorable for the development of this method has long been a cent a mile per M board feet. With such a low charge

no other method can compete. Unfortunately, however, driving cannot be employed everywhere. It is first of all necessary that the timber to be taken out will float readily. This most hardwoods will not do and even some softwoods need special treatment. Then, too, many sections of the United States do not have suitable climatic conditions. The rainfall is either inadequate or improperly distributed. Consequently, this cheap and effective method is frequently impossible.

Under such circumstances railroad logging offers the most effective substitute. In the redwoods the cost per M has usually been estimated as five cents per mile. Naturally such a cheap method is the first choice with all kinds of hardwood and where the climate and topography are unfavorable to driving. But the initial investment per mile is always heavy and is not justified unless the stands are heavy per acre or the railroad can ultimately be converted into a common carrier. As a result there are many woods operations where the use of railroads is out of the question. These fall into four main groups:

1. Operations where sleds can be used
2. Operations where wagons must be used.
3. Operations where chutes must be used.
4. Operations where flumes are most economical.

Snow is the best road material in the world and where several months of good sledding are assured that is by all odds the best method to employ. Thirty-five cents per M and mile have been attained in many cases. Like driving, sledding has evolved from simple beginnings to elaborate processes for icing and keeping clean the roadbed. There are, however, many sections of the country where the snowfall is not great enough to permit of the use of sleds. Wagons are then the only recourse. The motive power may be either oxen, mules, horses or tractors and the wagons either low wheeled or high. But whatever the appliances used this is a relatively expensive method. Seldom can it be done for less than $1 per M per mile. The remaining two methods, chutes and flumes, are special ones only applicable in special cases. Chutes are often the only recourse in steep, rocky country while flumes require a large supply of water. No general

figures can be given for the cost of these last two methods since each case presents a separate problem.

The forest types cannot be grouped definitely by methods of hauling because two or more methods are commonly used in each. The circumstances of the individual operation determine which is the most economical. However, the following summary of costs of transport from stump to mill may be useful as a general guide:

I. Cost per M low — $2 per M or less before the War — three man hours and four horse hours per M — short haul to mill.

Second growth white pine.
Engelmann spruce.

II. Steam yarding and railroad hauling — heavy stands of large timber — long haul to mill — $5 per M in 1914. Three to four man hours per M and large interest and depreciation charges on machinery.

Douglas fir.
Redwoods and sequoia.
Western red cedar.
Sugar pine.
Alaska coast.

III. Short haul to drivable stream — $6 per M in 1914. Six man hours and not more than our horse hours per M

Southern bottomlands.
Alaska interior.

IV. Animal skidding and hauling — long haul — 9 to 10 man hours and 10 to 20 horse hours per M. Seven to eight dollars per M in 1914.

Lake States white pine.
Silver pine.
Southern pine.
Western yellow pine.
Northern spruce.
Northern swamp.
Lodgepole pine.

V. Hardwoods. Long haul. At least 10 man hours and 20 horse hours per M. Ten to fifteen dollars per M.

Northern hardwoods.

Southern hardwoods.

Tropical hardwoods.

The cost of milling is determined directly by the number of operations carried on in the mill in question. A small portable mill which only does sawing used to charge from $2 to $3 per M depending upon the size and amount of timber to be sawn, *i.e.*, the cost of sawing was three to four man hours per M plus fixed charges. This is the simplest case. Even the sticking of the lumber was contracted separately. In larger mills, however, the cost of milling or manufacture includes a large number of items. Even before the logs reach the saw boom charges have to be met in mills located on streams where the logs of a number of companies are passing. They are then hauled up the ladder into the mill and go to circular, gang, or band saws. Just beyond the saws stands a grader who marks the number of board feet and the quality on each board. Some boards go directly to the mill yard to be stacked while others are taken to the planer, dry kiln, or cut up for special purposes. Slabs go either to the engine room for fuel or are made into shingles or laths. Not every mill of even moderate size has all these supplemental processes. Hence the total sawmill charge varies with each individual case. For mills equipped with planers, kilns, and lath machines the charge is never less than $5 per M and may run up as high as $7. This means seven to eight man hours per M plus interest and depreciation charges on the mill equipment. These figures apply to softwoods only. Hardwoods always cost more, varying from 150 to 200 per cent of the charges for softwood.

Regionally the great variation in milling costs comes with the use of permanent or portable mills. The standard mill has been one which assumed at least a 20-year cut and was, therefore, equipped with all the supplemental machinery that economic conditions permitted. Commonly it had two or three different kinds of saws, a capacity of over 20M feet per day and might even build up enough of a population in its immediate vicinity to fur-

nish a market for the waste wood which would otherwise have to be burnt. Frequently, one or more wood using industries sprang up in the neighborhood and depended upon its by-products for their raw material. Such a mill is economical in its use of the logs brought to it but it must have a large body of good timber to draw upon. In the woods the utilization is usually low because only the better logs will repay transportation. Consequently it has frequently happened that only 30 per cent of the tree has been taken out for lumber.

The portable mill is an attempt to meet conditions entirely opposite to those under which the large mill works most advantageous y. When a section has passed from the pioneer timber-mining stage into the farming era there still remain many bodies of timber which are too small for the large mill to handle. Instead of hauling the logs to the mill, the mill goes to the timber. The good roads of a farming community make this possible. All the valuable timber is salvaged and yet only light, seasoned lumber is hauled out. The portable mill justifies itself by the saving in transportation charges alone. However, conditions do not warrant its use in many regions as yet. The farm woodlot is its field of greatest usefulness so that it is successfully employed in the following types in many instances:

Northern spruce.
Northern hardwoods.
Second growth white pine.
Southern pine (especially second growth).
Southern hardwoods (cove, slope, and ridge).

Likewise the scattered stands of the Rocky Mountains make it applicable in the following types:

Engelmann spruce.
Lodgepole pine.
Western yellow pine.
Fir-larch.

The other types are almost universally logged to a large mill because they have extensive stands of timber which justify the development of means of log transportation.

Neither type of mill so far discussed fills the needs of a tract which is being handled on a " sustained yield " basis. The large mill demands logs and more logs. The larger the output, the less the depreciation charge per M. As a consequence this type of mill has always left in its wake denuded hillsides cut without any thought of regeneration. Future growth was sacrificed ruthlessly to present profits. The portable mill has likewise been an active agent of forest destruction. The desire to get enough to make a setup pay has frequently led to the cutting of immature timber and little attention has been paid to keeping the logged area in productive condition. Furthermore the portable mill is not well adapted to the manufacture of anything but low grade softwood lumber. The foundations are not stable enough to permit accurate sawing of hardwood nor is the circular saw economical with high grade softwood. And yet the circular saw with its big saw kerf has proven more satisfactory in the portable mill than the more thrifty band saw.

When a tract is being handled as a permanent forest investment no more than the growth should be cut so that the capacity of the mill must not determine the annual fellings. Furthermore, every tract has a variety of species demanding various methods of manufacture if they are to be put in the best form for sale. Consequently, the mill should have planers, edgers, lath machines, shingle machines, and perhaps a dry kiln. In other words, a versatile mill well within the growth capacity of the tract is needed, not a highly specialized one devoted to a high output of one kind of lumber.

Cost of Logging and Manufacturing Other Products. — Ranking next in importance to lumber firewood receives second consideration. From stump to stove it passes thru the following processes:

Felling, splitting and cutting up into four or eight foot lengths.
Seasoning.
Hauling.
Sawing up.
Marketing.

The standard pile of firewood is four feet high, eight feet long and four feet wide. One man may work effectively in putting up wood in this way but two are better when there is much splitting and sawing. The amount that can be done in a 10-hour day varies with the species, the size of the timber, and the skill of the workman. Softwood is roughly twice as easy to chop as hardwood. In other words the chopper who will put up two cords of softwood per day cannot average better than a cord of hardwood. The size of the timber is also an important factor. Either large or small stuff goes slowly. The ideal size for chopping is a tree about eight inches in diameter breast-high. Assuming then that from one to three cords may be cut per day the cost per cord of putting up firewood in four foot piles with all the pieces over six inches at the top and split, ranges from $1 to $4.

Ordinarily the wood is seasoned in the place where cut before hauling. The cost of this is so small that it is usually neglected. It simply amounts to the interest on the money tied up in the firewood for four to eight months. The shorter period will remove two-thirds of the moisture but eight months is required to thoroughly air dry hardwood.

The cost of hauling varies directly with the weight of a cord of seasoned wood. This ranges from over two tons for hickory to one ton for soft pine. Consequently the cost per cord has varied from 50 cents to $1 per cord per mile.

Firewood may be marketed either in four foot lengths or sawn to 16 inches so that it will go into a stove and then retailed. Sawing into short lengths has cost from 50 cents to $1 although prices have advanced since 1917.

It is apparent from the foregoing discussion that the main factor in determining the price of firewood is the distance which it has to be hauled. The other operations have cost uniformly before the recent advance in prices about $3 per cord for softwood and $5 for hardwood. Consequently the maximum distance which wood could be economically hauled was fixed by the price per ton of its competitor, coal. With the latter retailing at $10 per ton both hardwood and softwood could be hauled about five miles with the ordinary types of conveyances. This is based

on the assumption that hardwood has twice the fuel value of softwood and is equal in fuel value per cord to a ton of coal. To the objection that this is too favorable to wood it may be urged that wood is a more flexible fuel than coal and is therefore used more economically.

Pulpwood, extract wood, and acid wood present the same problems as firewood and have the same costs.

Poles, whether intended for telegraph, telephone, or mining purposes, represent one of the most economical ways of using timber because there are few steps in their manufacture. They are simply cut off at the stump and top and peeled and are ready for use. These operations seldom cost more than $3 per M so that the determining factor was the distance they had to be hauled. One dollar per M per mile has been an outside figure for the latter operation although recent advances in wages and horse hire have upset even such a conservative figure.

Railway ties go through the following processes:

Felling and bucking.
Hewing or sawing.
Hauling.

The cost of these steps per tie varies with the size of the average tie. The standard for steam railway use has been a tie with an eight-inch face and eight feet long. Switch ties were even longer, usually 12 feet. Trolley railroad ties, on the other hand, are smaller, being satisfied with a five or six inch face. Hence the number of ties per M ranges all the way from 40 to 20 with an average of 30 for the standard railway tie. Hewing is the only new item and this has been done in most cases for less than $1 per M. The distance hauled has, of course, varied a great deal but the margin between the sale value, $12 to $18 per M and all costs including stumpage has seldom permitted ties to be hauled by wagons more than eight miles.

The cost of handling tanbark can best be expressed in values per M of timber felled because it is seldom advisable to cut hemlock or chestnut oak bark for the tanning material alone. The usual method is to handle it as a by-product. Hence, the woodland owner wants to know not how much bark an area will yield

but how much bark he will get from a certain amount of timber. This cannot, however, be stated with exactness, because it varies with the locality. In fact the factors which control it have not yet been worked out for all conditions. But the range is not great. From one and one-half to two M board feet are required to yield a cord of bark.

The important factor in bark costs is, of course, the distance which it has to be hauled although this seldom amounts to as large a sum as the cost of peeling and drying. The latter is, however, a more or less fixed quantity in all parts of the country so that the factor which fixes the difference in value between the bark of different localities is after all the distance which it has to be hauled.

Average bark costs have been as follows:

Peeling and drying..... (Four men will cut and peel five to eight cords per day.)	$2.00 per cord.
Hauling.....	0.75 per cord.
Loading.....	0.75 per cord.
	$3.50 per cord.

Expressed in terms of board feet it took in 1915 approximately $1.75 extra per M to take care of the bark.

Posts are a relatively unimportant item as compared with the other products of the woods yet in the aggregate they total a billion board feet annually the country over. The cost of getting them is small per unit but large per M because of the small size of the units. Seldom do posts cost more than 20 cents to make and deliver but this amounts to approximately $20 per M.

Profit. — Trade secrecy has been the main obstacle in reaching a general agreement as to what is a reasonable profit in a lumbering operation. Lumbermen have been loath to speak frankly of anything but their losses but even this has failed to allay the suspicion — often wholly unfounded — on the part of the general public that enormous and unearned fortunes were being made out of the business. Much of this misunderstanding has arisen from a failure to realize that the returns must be high in lumbering because the risks are great. Weather conditions cannot be con-

trolled in the woods as they can under a factory roof. Labor is necessarily nomadic under the present system because the men cannot take their families into the woods with them. The professional lumberjack is notoriously a drifter. It is a common saying that a large operation needs three full sized crews, one working, one going out and another coming in. In other words, the difficulty of breaking in new men, common to most industries, is magnified and accentuated in lumbering. Then, too, capitalists are commonly not so familiar with the technique of the business as with that of the merchandising and manufacturing industries so that they are less willing to finance logging operations. Added to their unfamiliarity with the methods of the business is the long period frequently required to realize on the investment. Where an expensive mill must first be erected and logging railroads built the capital cannot be retired for 10, 20 or more years. The combination of these factors makes the rate of return necessarily higher than it is in industries with a quicker turn over, better understood, more easily standardized and less hazardous. While a gross margin of 10 per cent is ample in the wholesale grocery business, or the manufacture of shoes, 25 per cent is none too much in many lumbering operations.

What the rate should be for any particular operation depends upon several factors. The highest return is naturally demanded in the more hazardous operations like the opening up of a new region. An example of such an enterprise is the beginning which has just been made in the exploitation of Brazilian timber. Methods and markets must be developed and the operation has all the hazards of a pioneer enterprise and is accordingly entitled to a high return to offset the extra costs and unforseeable losses. On the other hand an operation in a region where the methods are standardized does not require so great a return. An example of this latter kind is a New England portable sawmill enterprise. Intermediate between these two extremes are the medium sized job in a region where logging is one of the principal industries and large enterprises which open up new blocks of timber in sections where markets are assured and the best methods have already been worked out.

Next to hazard the most important factor in determining the proper rate of return is the frequency of turnover. A chestnut acidwood operation in which wood may be converted into ready money as soon as cut and hauled does not, naturally, require a large return on the single job because the capital invested may be utilized again and again during the year. For example, if two months of cutting give a return of 3 per cent on the investment and five such operations are carried on during the year it is obvious that the annual return will be 15 per cent. On the other hand an enterprise which must have its logs come on a six months' drive and season its lumber another six months, must in justice receive higher return per unit of finished product whether that be cords or M feet board measure.

Size is a factor likewise in determining a fair profit. A large amount of capital invested for a long period in an enterprise which is safeguarded by its own bulk does not need such a high return as a small enterprise which must fight its way at every step to keep its larger competitors from crowding it out. Hence the small jobs involving relatively few men and teams should pay a higher return per M than the large sawmill fed by its own logging railroad and controlling many thousands of acres of stumpage.

While generalizations cannot be safely made without allowance or exceptional cases it may be said that the following rules will apply in most cases:

1. Operations in regions where the methods are thoroughly standardized, as for example the New England portable sawmill region, are content with net profits of $1 to $2 per M.
2. Operations of medium size in less well settled regions demand average returns of 25 per cent per M on the capital invested.
3. Large operations involving investment for 20 years or more are content with a return of 10 per cent on the total investment.
4. Pioneer enterprises, whatever their size, should have a return of 25 per cent per M on the investment.

Exactly what constitutes the investment per M is sometimes difficult to determine. Small operations present no special difficulty because the capital is small, consisting of relatively few tools, a team or two, wagons or sleds, and the amount necessary to carry the payroll, interest charges, taxes, and insurance. The sum of these items divided by the number of M feet to be logged gives the investment per M. Furthermore, the contract prices being paid in the region for the different steps from the stump to the stick furnish the best kind of a check since they are the combined judgment of the community as to what must be invested per M to get the desired results. Much more difficult to determine accurately is the proper charge in large and complicated enterprises. However, the following list of items which may enter into this total may be useful in checking over to make sure that nothing has been overlooked:

1. Permanent improvements or durable equipment like a railway or sawmill to be used over a long period. The charge per M is determined by dividing the total for these items by the whole amount of timber to be manufactured with them.
2. Operating costs such as wages, food supplies, destructible tools, interest on operating capital, taxes, overhead costs, etc. These are usually totaled annually and divided by the cut for that period.
3. Maintenance charges such as depreciation costs, amortization payments, insurance, etc. These may be most conveniently calculated on an annual basis.

Freight Charges. — Absolutely and relatively freight charges are the most important single item in wood product costs. For example in lumber retail prices the various steps are divided as follows on the average:

	Per cent
Logging	25
Milling	20
Freight	27
Wholesaling	3
Retailing	25
	100

For the northwest the ratio of freight costs is even greater. For example in the case of Oregon or Washington Douglas fir 35 to 40 per cent of the retail cost goes for freight costs. Even in the southeast the charge to the large markets represents 15 to 25 per cent of the total cost.

In Butler's report on "The Distribution of Softwood Lumber in the Middle West," he gives the following freight charges per M and per 100 lb. using pre-war rates:

	Per M	Per 100 lb.
		Cents
Portland to Chicago	$13.75	55
Westwood, California to Chicago	12.50	60
Cœur d'Alene, Idaho to Chicago	9.88	52
Bogalusa, Louisiana to Chicago	6.12	24½
Bemidji, Minnesota to Chicago	3.20	16

Briefly summed up, it may be said to cost less than $5 to get northeastern lumber onto the general markets, between $5 and $10 for freight from the southeast, and $10 and $15 per M from the Rocky Mountain and Pacific coast regions.

The Interstate Commerce Commision Report for 1918 gives the annual freight bill paid by the lumber and forest products producers of the United States as $215,000,000. Of the total railway tonnage they constitute 11 per cent, being exceeded only by mineral products and general manufactures. As compared with lumber soft coal yields 34 per cent less revenue per ton mile, hard coal 13 per cent less, and grain 9 per cent less. Dressed meat and cotton pay 26 per cent and 60 per cent more per ton mile, respectively.

Freight rates are of various kinds. The following need definition before the general subject can be discussed further:

(1) Commodity rate — a freight charge levied against all articles of the same kind. For example the rate for lumber for a 60-mile haul on the Boston & Maine Railway is $2.85 per M while logs take a different commodity rate and cost $3.95 per M even for softwoods. With forest products three commodity classes are usually made: "(1) rough products such as logs, bolts, or

flitches; (2) lumber or other partially finished articles, not yet worked into a final manufactured product; (3) finished articles like boxes, barrels, doors or blinds; and (4) 'woods of value' such as walnut and mahogany."

(2) Local rates are rates which apply between stations on the same railway system, usually within a state.

(3) Thru or joint rates, on the other hand, apply to shipments made for long distances, commonly over two or more railways.

(4) Combination rates are rates which are the sum of two or more local rates with or without reduction.

(5) Basing rates are the sum of a thru rate to a terminus like New York and a local rate to the point of destination. For example, the all rail rate from Chicago to Bridgeport, Conn., would be the thru rate from Chicago to New York plus the local rate between New York and Bridgeport.

(6) Manufacture-in-transit rates permit the conversion of logs into rough or dressed lumber en route. For example, a lumber concern may ship its logs to the mill where they are sawn and planed and then re-ship the lumber, all on the same rates. Such rates are really combination commodity rates with special privileges in regard to the use of the freight cars employed.

In any consideration of the subject of forest product freight charges it must be constantly borne in mind that these industries have seldom received any special consideration on the part of the railroads. The freight agent has tried to make his charges "as high as the traffic would stand." Consequently higher rates are applied to the more valuable classes and grades whenever they can be easily distinguished. This is usually taken care of by the commodity classification already discussed. For example, cabinet woods pay more than ordinary softwood lumber. There is, however, one apparent exception to this general rule. Dressed lumber commonly pays no higher rate than rough lumber, although there may be a difference of $50 per M in the sale value of the two. But the reason for this is not far to seek. It is simply a matter of convenience. The cost of inspection on the part of the railroad would be excessive, it is feared, were the freight rates varied with the grades. As a result seasoned and dressed

lumber pays much higher returns than unseasoned rough lumber because it is lighter in weight, less bulky for the same quantity and has a wider margin for profit. To show how this works out take the case of the sawmills in Oregon and Washington. With a $15 per M freight charge to meet they can only afford to ship east their best grades. There is no margin for profit on common and boxboard lumber. And the same holds true in greater or less degree for all the centers of forest production. Freight rates encourage skimming off the cream only.

Foreign freight rates per ton mile are higher as a rule than ours for all commodities. For example, our average rate per ton mile in 1914 was approximately 8 to 10 cents while in the United Kingdom the rate was nearly three times this in 1913. Denmark's rates were even higher. Russia and Japan were the only countries that had average rates at all approaching ours. Forest product rates furnished no exception to this general rule. As against an average rate of 3 to 10 cents per ton mile for transcontinental lumber shipments the lowest rate that Dr. Schenck cites in his discussion of freight rates is 4 to 10 cents per ton mile and this was a special rate from Austria to Germany and France intended to offset the import duties levied by the latter against Austrian lumber. But there is one marked difference between European and American practice. The former makes a difference between grades of lumber. For example, the rate for distances over 220 miles is double for lumber what it is for pulpwood, firewood, mine props and railway ties. From the standpoint of forest production this is a very valuable arrangement since it places no premium on the marketing of the higher grades but gives the poorer grades a fair chance to reach the general market. What such a change would mean to the American forests can be quickly shown by two examples. In the northern hardwood type the principal silvicultural problem is the removal of the mature hardwoods in order to give the more profitable spruce, fir and pine a better chance. At the present time only the very best parts of the hardwood trees are reaching the sawmills. By lower rates on the poorer grades of hardwood lumber and especially on cordwood the woods in this type could in many

instances be put in good silvicultural condition. A still more striking illustration is furnished by the freight rates on northwestern lumber. Since no difference is made in the rates on clear and common lumber, the profits are much greater on the former and only the good butt logs are taken out of the woods. The second grade logs rot in the woods and the slabs are burnt at condesirable expense.

Stumpage Prices.— Using the formula that stumpage prices should equal the difference between the average sale value of the various grades obtainable from a stand of timber and the sum of all the costs of logging, manufacture and transportation including a fair profit, the determination of stumpage prices would appear simply a matter of mathematical calculation. There is, however, still another factor that needs to be considered. This is the lag of stumpage prices behind fluctuations in lumber prices. The main reason for this is that standing timber is not at present an easily negotiable commodity. Forest conservation has not as yet reached the point where timberland is considered as first class security. Fires, insects, fungi, uncertain labor conditions and inclement weather must be circumvented before stumpage can be converted into ready cash. Consequently, when lumber advances there is no immediate rise in stumpage prices because a standing tree has to go thru many processes before it yields boards. Furthermore, the cost of these processes may have increased to the point where any advance in the price of the finished product is absorbed long before the stumpage price is reached. For example, a 40 per cent increase in lumber prices has no prospect of effecting a similar rise in stumpage figures when there is a 100 per cent increase in the cost of food and wages. This condition actually prevailed during the Great War.

How much difference there should be between the rate of change in lumber prices and the rate of increase or decrease in stumpage cannot, of course, be definitely stated. It depends upon various factors which differ with the locality and season. In general, however, it may be taken as a safe rule that the stumpage price determined by formula needs discount by an amount sufficient to allow for probable changes in costs. The

future trend of costs must be considered because no one is going to make changes in stumpage prices for passing fluctuations in costs. For example, a temporary increase in the price of corn need not affect disadvantageously the price of pine stumpage even tho corn is fed to both men and mules. There is a good chance that by the time the lumber is ready for market the price of corn may have changed again, and for the better. Yet, on the other hand, the logger and sawmill man must be on the lookout for possible increases in costs so that they do not pay so much for their logs that their margin is entirely wiped out by an advance in food or labor.

Of the factors that determine stumpage prices the costs of hauling the logs and the lumber are the most important. The other factors only vary within narrow limits. As a consequence the stumpage price of any piece of timber is dependent primarily upon its distance from a sawmill and the length of freight haul from the mill to a market. To illustrate take two such unlike softwoods as second growth white pine and redwood. Of course, the latter yields very much better grades than second growth white pine because the pine has seldom been allowed to grow more than 100 years while five times that would be nearer the average age of the redwood which is now being cut. In fact second growth pine yields no wide clear lumber. The percentages of the grades obtained from each would be about as follows:

	Redwood	Second growth pine
	Per cent	Per cent
Wide clear lumber	15	.....
Shop	20	5
Common	25	10
Boxboards	40	85
	100	100

Nevertheless the average sale value for both at the mill has been about $30 per M for the log run, with redwood averaging not more than 20 per cent higher than the pine. In the same way the logging costs did not vary greatly. Before the war $5 per M would have covered all costs from stump to mill pond in either case.

Milling has been slightly higher in the case of redwood because some of it was planed but $10 was a safe figure for the total cost of the finished lumber in California or New England. Consequently there would remain a margin of $20 — sale value of $30 less costs of $10 — to cover freight charges and stumpage price. In the case of redwood even pre-war charges took fully three-quarters of this margin of $20 while one-quarter was ample to cover all freight costs in the case of second growth pine. Hence, the stumpage price of redwood has never been over $5 per M while that of second growth white pine has already gone over $10 per M in the case of accessible tracts.

The general rule that sale values, logging costs and manufacturing costs are relatively constant and that freight charges fix stumpage holds for hardwoods as well as softwoods with a few rare exceptions. These deviations from the rule are the rarer cabinet woods like walnut, mahogany, etc., in which the sale value is far above that of ordinary lumber. But even with these the stumpage price of different stands of the same species is fixed by the distance from mill to market. For example, walnut near a furniture or gun factory in Ohio is worth two or three times what the same or better quality of tree is valued at in the mountains in Kentucky.

Since then the general rule holds that stumpage prices depend upon distance from market it follows that they must be approximately the same within a given region tributary to any one market. Markets may be either local, special or general. The first are the best in all cases because they reduce freight charges to a minimum but unfortunately no local market is unlimited. Most are, in fact, of small capacity in power to absorb such a common product as lumber. The same applies to special markets. They can only take particular grades and those in limited quantities. Hence it follows that the general markets are the great price fixers in the forest product industries. Indirectly they also determine sale values in the local and special markets because no local price can exceed for any length of time the general market level plus the freight charges from the general market to the locality in question.

The great general lumber markets of the United States are simply distributing points into which the mill men ship their lumber and from which the wood users purchase. This means that they are located at the termini of water routes and the supply points for manufacturing and agricultural centers. Every city of any size answers one or both of these qualifications in some measure but the following are preëminent as lumber markets:

Boston — the commercial center of New England.

New York — a great supply point for all sorts of native lumber and also the largest importer of tropical hardwoods.

Baltimore — by reason of its advantageous tidewater location an important distributing point for pine from the south Atlantic states.

Norfolk — a good harbor makes this city the natural export center for Virginia, West Virginia and North Carolina.

Buffalo and North Tonawanda — at the eastern end of the Great Lakes and hence the natural eastern market place for lumber from the Great Lakes region and the upper Mississippi valley.

Chicago — the distributing point for the north central states.

Minnesota Transfer — the transfer point for western lumber coming east, especially that from the northwest.

Cincinnati — an important distributing center for southern hardwoods.

St. Louis — important in the southern pine and hardwood trade because of its location on the Mississippi River.

New Orleans — used both as a market for southern pine and cypress from Texas, Arkansas and Louisiana and an exporting port.

San Francisco — the export center for redwood and sugar pine.

Portland, Oregon — a red cedar shingle center and shipping point for northwestern lumber in general.

Seattle — the principal port of export to the Far East of Douglas fir lumber and red cedar shingles.

Spokane — the distributing center for the Inland Empire and the marketing point for silver pine, western larch and Douglas fir from northern Idaho and eastern Washington.

Since then the timber with the shortest haul to market has the highest value it follows that the highest stumpage prices will be found in the eastern part of the United States where the bulk of the population lives and the major portion of the manufacturing is done. White pine, walnut and white ash have already reached stumpage prices of $15 per M board feet in New England, New York, Pennsylvania and the Lake States. From this maximum prices taper off to the vanishing point for the less desirable species in inaccessible localities. In the southeast yellow poplar, yellow pine, cypress, walnut, ash and oak have all risen in value to nearly $10 per M on accessible properties. The less valuable hardwoods, like black oak and tupelo gum for example, are, however, still selling for less than $5 per M. In the Rocky Mountain region and on the Pacific coast stumpage prices are in general well below $5 per M even for the largest and most accessible timber. In fact the only places where anything like this amount has been realized have been isolated communities in the semi-arid districts where the supply of standing timber was limited and long wagon hauls made importation out of the question.

Stumpage prices are governed by distance from market almost irrespective of use value. In other words, no matter how fine timber may be it must be near to market to bring a good price standing. An extreme example of this is the case of the tropical hardwoods. Bringing fancy prices at the wholesale markets in the form of boards or even hewed logs the trees themselves are worth less than $1 per M. The cost of logging with native labor in a tropical climate and the long sea voyage absorb all the margin which with more accessible species goes to the owner of stumpage.

In order to determine what prices will be in the future it is necessary to know how they have acted in the past. Fig. 14 brings together figures on past stumpage prices. Furthermore Sauerbeck's index figures are given in order to give a basis for comparing fluctuations in stumpage prices with the changes in

general commodity prices. The Prussian and Saxon figures are perhaps most interesting because they cover the longest period. For instance, during the period 1830 to 1875 Saxon wood values increased at the rate of 4½ per cent compound interest annually. In Prussia, which has poorer markets, the rate of increase during the same period was 2½ per cent. For the 70-year period from 1830 to 1900 the rate of annual increase in Saxony was a trifle less than 3 per cent while Prussia maintained a rate of 2½ per cent for this longer period too. Hence Doctor Fernow's statement that German stumpage prices have been increasing at the rate of 2 per cent per annum, compound interest, for the last hundred years is amply conservative. Nor is the force of this vitiated by corresponding increases in the prices of other commodities. On the contrary general commodity prices decreased quite steadily from 1820 to 1895 with a few minor exceptions. Their rise during the Great War is, of course, due to special causes outside the usual laws of supply and demand.

Our own experience substantiates European experience. White pine stumpage, for example, increased at the rate of 6½ per cent, compound interest, in Michigan from 1865 to 1905 and at the annual rate of 7½ per cent in Minnesota from 1880 to 1905. These increases are all the more remarkable in the face of a marked decrease in general commodity prices, from 1865–1895.

Another point still more clearly brought out in the chart is that the rate of increase has not been uniform. There have been distinct ups and downs. For example, the effect of the Franco-Prussian War is clearly shown in both the Saxon and Prussian curve — a sharp rise followed by a drop and that in turn giving place to a slower recovery. In the same way 1907 marked the highwater mark for stumpage prices in the United States until the rise brought about by the Great War. In fact the period from 1908 to 1914 was one of distinct stagnation if not depression in American lumber circles.

But in spite of occasional drops the general increase is so apparent that it may safely be laid down as a general law that the trend of stumpage prices has been upward the world over for the last hundred years in spite of the opening up of many new timber

regions. For example, the export of lumber from America to Europe in any considerable quantity has all occurred during this period and the center of production has moved from the northeastern states to the southeastern pine region and is now about to jump across the Rocky Mountains to the Pacific northwest.

Substitution has also been a factor which might have affected seriously the demand for wood and been reflected in lower stumpage prices. The consumption of cement, for example, has increased from 11 million barrels in 1892 to 90 million barrels in 1913 with a corresponding decrease in the cost per barrel. Coal and steel have likewise taken the place of wood in many ways. Thelen estimated in 1917 that "approximately 70 per cent of the present cut of lumber goes into forms of use whose demands appear to be decreasing." The plain fact is that substitution will undoubtedly go much farther. The crest of lumber production is undoubtedly behind us. There has been a steady decrease in the amount of lumber sawn since 1909. But the important point is not that we are using less wood but that we have been using it lavishly. Our consumption per capita was estimated in 1900 to be approximately six times that of Germany, seven times that of France and 16 times that of Great Britain. We have not only used wood "from the cradle to the coffin" but wallowed in it en route.

This does not, however, mean that wood will in time be replaced either in whole or to any considerable extent. It has too many valuable qualities to be entirely superseded. It is light, strong, easily worked, durable, a non-conductor of heat and electricity and best of all relatively cheap even assuming that prices will reach throughout the world the level attained in the European countries which do not grow enough for their own use. As compared with a piece of iron of the same weight a stick of yellow pine is six times stronger and very much cheaper. So it is safe to assume that wood will always be in great demand for a very large number of uses.

But its value in construction and manufacture is not the main reason for predicting advancing values for wood. The decreasing supply is the controlling factor. This fact is one difficult for

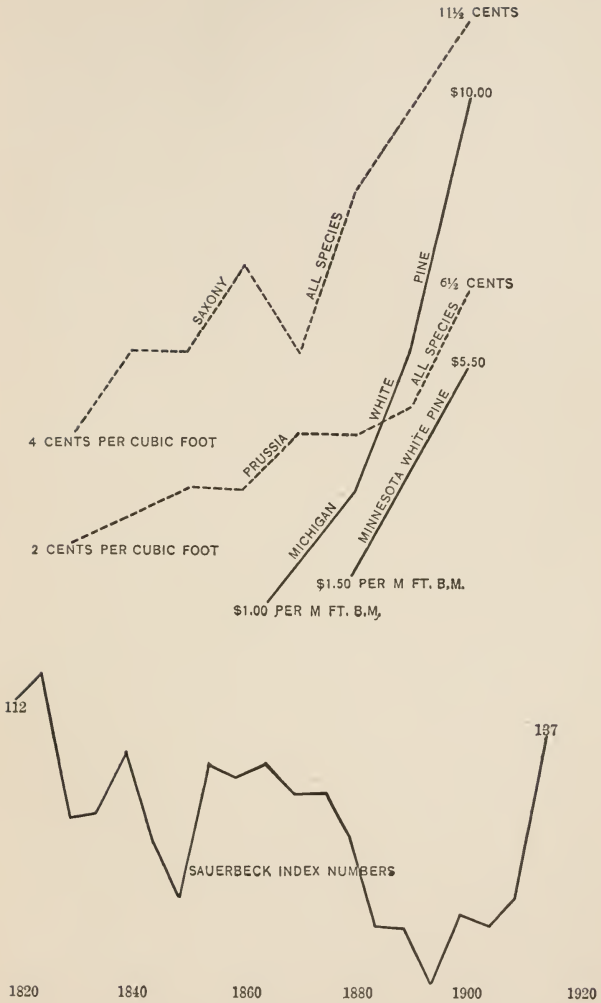

FIG. 14
Comparison of the cost of living and stumpage prices.

most of us to realize. We may have seen one kind of lumber vanish from the market because it had been overcut but there have usually been competitors to take its place. For example, eastern white pine is very difficult to secure at the present time in large clear boards but western silver pine and sugar pine are essentially the same in quality and obtainable in large sizes. Cannot this substitution continue indefinitely? Prior to the Civil War the New England and Middle states were the principal producers of lumber. Then the ascendancy passed to the Lake States without necessitating any great economic readjustment because the species were the same. It was simply a question of paying a greater freight charge. But by 1900 the southeast was cutting more than the Lake States and by 1909 nearly four times as much. This meant not only a longer haul for northern wood users but entirely different species. Hence, serious readjustments in machinery, methods, costs and selling prices were made necessary. Now the southern pine region is being forced into second place by diminishing supplies of standing timber and the Pacific northwest is forging ahead. By 1925, 3000 sawmills will have to shut down because there is no more southern yellow pine for them to cut. Had the War come 10 years later the lumber for cantonments, ships and airplanes would have had to be shipped almost entirely from the Pacific northwest. What this would have meant in delay and extra freight charges is almost incalculable. Furthermore, the supplies in California, Oregon, Washington and Alaska are not unlimited. The large merchantable timber is confined to a rather narrow belt along the coast where the influence of the moist winds from the Pacific is felt. Behind — to the east of — the Cascades and Sierras there is no good timber except on the scattered islands of mountains which reach up far enough out of the arid plain below to get some rainfall. The Rocky Mountain region has been sarcastically characterized as "fit only for prairie dogs, rattlesnakes and invalids." Certainly it has no timber to spare for export. In other words, the states of New Mexico, Colorado, Wyoming, Montana, Idaho, Utah, Arizona and Nevada need all the timber they have for their own domestic development. This

also applies to southern California, and eastern Oregon and Washington. So it sums up to this: the supplies of virgin timber are virtually exhausted except for a limited area on the Pacific Coast making up less than 5 per cent of the total area of the United States. Nor does the fact that some of the biggest trees and the heaviest stands in the world are located here offset the fact that the end of the original supply of timber is in sight.

What relief can be expected from other parts of the world? England has long since given up producing her own wood supplies but depends upon importing them. Why cannot we do likewise? This seems all the more plausible because the ordinary description of any new country, and of many that have a long history, makes much of "the inexhaustible forest resources." It will come then as something of a shock to most people to know that only 25 per cent of the earth's surface is capable of producing trees of saw-timber size. The rest is either too cold or too dry. Furthermore the area of good softwood timber is still further restricted. Practically speaking, there is no good softwood out of the northern hemisphere. Siberia, Prussia, Scandinavia, Canada, and the United States are the only countries that even had large bodies of pine, spruce or fir. Tropical forests are primarily hardwood forests. The dipterocarps will only be used for the local softwood demand and they will have to make slow headway against the northern softwoods which now preëmpt the tropical markets. Consequently no help may be expected from Europe, Asia, Australia, Africa or South America. All these continents have, in fact, been drawing upon our supplies in the past and would like to continue to do so. In other words, we know that the original world supply of wood will not last indefinitely. We must either use substitutes or grow more. Entire replacement is neither desirable nor necessary so that the cost of growing it will soon determine throughout the world the value of the standing timber.

What the cost of production will be is dependent upon a number of factors. Most important of all is the length of time required to produce material of any given size. Minimum and average figures are the only ones worth considering because they

will determine in the main. It is conceivable that under untoward climatic conditions cordwood may require for its growth as long as high class sawtimber, but the places that can produce cordwood in a reasonable period are going to set the price. Accordingly the following figures will be used:

	Years
Cordwood requires	25
Boxboards require	50
Dimension lumber requires	75
Lumber for "cutting up" requires	100
Wide, clear lumber requires	150

To illustrate how these figures were derived take white pine as an illustration of a softwood and red oak for the hardwoods. For the periods given above their diameters breast-high are as follows:

	White pine	Red oak
	Inches	Inches
25 years	5	5
50 years	10	10
75 years	15	12
100 years	20	15
150 years	25	20

Next to the question of time required the problem of determining the proper interest rate is the most vital. It is also the most complex and difficult to reach common ground on. Where most of the misunderstanding comes is in the varying conceptions of what constitutes "net income." The ordinary business man takes this as meaning what is left for him after he has paid his debts and frequently he forgets such untangible liabilities as interest on his investment, depreciation, overhead expenses, etc. Consequently he assumes, and rightly, that he must make from 10 to 20 per cent per annum on his investment. But the business of growing wood differs radically from the ordinary business of small capital and quick turnover. The main item of expense is the interest on the capital tied up in the land, the expense of planting or regenerating naturally, and the annual cost of administration and protection. While none of these is large in itself the interest on them for a period of 50 to 100 years

amounts to a large sum. In other words forestry is one of the few businesses in which no proper idea of the real cost of doing business may be obtained unless due allowance is made for interest charges. In merchandising and manufacturing on the other hand the main items of expense are the cash outlays for material and labor and interest charges play a relatively unimportant rôle. Interest is, in fact, a comparatively modern invention. Certainly the business man of 100 years ago worried little about interest, overhead charges, and depreciation. Forestry, a very new form of enterprise, is *ultra* modern in this respect. Consequently it must know what the net return will be after deducting all interest and charges for depreciation and other forms of overhead expense. The only kinds of business which are at all comparable are long time, conservative investments sought by those who wish a steady, sure income over a long period without the risk and bother of shifting their funds. The rents from an office building are an excellent illustration. Built to last for 50 to 100 years without radical alteration the main items of expense are the interest on the original cost of construction, the constant repairs to prevent depreciation, yearly taxes, annual insurance, premiums and administrative costs. Such a building gives a net return, when all these items of cost have been deducted, of not more than 3 or 4 per cent for long periods. In other words the capital is as safe and entitled to the same rate of return as funds invested in a savings bank. Government bonds are, perhaps, an even better illustration of what net income actually is. The recent Liberty Loans were floated at 3 per cent or more and at periods could be bought at enough below par to make the interest rate as high as 4 or 5 per cent. But no one expects them to remain at par. The Civil War loans did not and there is every reason to predict that both the Victory Loan and the three Liberty Loans will soon be selling for enough above par to bring their net return down to 2 or 3 per cent. And this will be a true net return barring perhaps the cost of the safe deposit box in which they are kept. They are not subject to taxes, they do not depreciate, or need repairs or insurance.

This then is the sort of income which is meant when net returns from forest land are referred to. All costs are included and interest figured on them from the time the trees are an inch high to their maturity. Furthermore, due allowance is made for possible loss from fire, insects, and fungi, and such items as are covered by insurance and depreciation charges, in the case of an office building. It seems reasonable, therefore, to use a low interest rate and 3 per cent has been chosen for the calculations given below.

The cost of the land has been set at $10 per acre. Only such soils should be devoted to tree crops as are unfit for tillage. This means steep, rocky or sandy land not good enough to plow. Hence a low figure is justifiable. Even in England with its ready markets and dense population the Forestry Sub-committee of the Reconstruction Committee estimated in 1918 that land could be bought for reforestation purposes for an average of $15 per acre.

For securing regeneration, whether natural or artificial, the cost is estimated at $10 per acre. This is somewhat low for planting on steep sites liable to wash, but high for natural regeneration. As an average it compares very favorably with the English estimate of $17 per acre " for planting, fencing, draining, beating up, etc.," where no natural regeneration could be expected.

This same report gives figures for the annual cost of protection and administration which are useful as a guide. For $1.50 per acre per annum it is expected that the protective and administrative officers may be paid and the necessary roads and buildings constructed and maintained. Hence, a figure of $1 per acre for protection, administration and taxes seems conservative for American conditions.

The total cost of growing timber per acre summing up all the items enumerated above is as follows:

	Years				
	25	50	75	100	150
Land at $10 per acre	$20	$43	$91	$192	$842
Regeneration at $10 per acre	20	43	91	192	842
Protection, administration and taxes	36	112	272	607	2766
Total	$76	$198	$454	$991	$4450

To determine the cost per M a uniform production of 500 board feet per acre per annum has been assumed. Hence, the following values hold at various age periods.

	Per M
25 years	$6
50 years	8
75 years	12
100 years	20
150 years	60

That these figures are not far out of the way is shown by the fact that some of them have already been attained in parts of the United States. Three dollars a cord or $6 per M is not an unusual stumpage price for accessible hardwood cordwood. Box-board material is selling for over $8 per M in all the more accessible parts of the second growth white pine region of the northeast. In fact it is only the production costs of the larger material which have not already been equalled or surpassed. So far the supply of large virgin timber has been great enough to supply the demand for high grade lumber at much less than it will cost to grow it. Yet, abroad, many stands are being managed on rotation of 150 years or more so that it seems only a matter of time before the United States, too, will be doing the same thing. Or, stated in a little different form, our stumpage prices for cordwood and the lower grades of lumber have already gone about as high as they will in the older, better settled parts of the country. High grade softwood and hardwood on the other hand, are now selling for much below the cost of production and will advance rapidly as soon as the accessible virgin supplies are depleted. This statement refers simply to stumpage prices, not to lumber prices. They are governed by entirely different laws. Even a decided

advance in the price of standing timber may produce only a slight increase in lumber prices because the cost of the latter is made up of many more elements than that of standing timber. Logging costs, milling, and freight charges are the important factors and far outweigh stumpage prices in determining the market price of lumber.

CHAPTER XXII

LAND VALUATION

While the value of the land itself has been practically negligible in the past in most sales of timbered lands, it is daily assuming a more important rôle. The days when a timberland owner could afford to throw the land away after he had cut off the merchantable material are over. The land itself, even tho it is rough and stony, can be used for the production of other timber crops or selected portions devoted to tillage, residence purposes, etc. Then, too, few cuttings absolutely denude the ground. There is usually some young growth which will become merchantable within a short time. For these reasons every timberland owner is more or less interested in knowing how much his land is worth irrespective of the merchantable timber on it.

The first step is to determine the area. Usually this is done in connection with the estimate of the timber and may vary in accuracy from the roughest kind of a guess to an accurate transit survey. Usually, however, a method midway between is chosen. Transit work is much too expensive except where the land values exceed $50 per acre which is seldom the case with woodland. The compass is the instrument most widely used in woods work because it is rapid and accurate enough if due care is taken in its use. Unlike the transit the adjustments are simple, it is quickly set up, stands hard service, and does not require much brushing or swamping. The commonest source of error is local attraction of the needle but this can be guarded against by back sighting. All in all it is the ideal instrument for the woodsman. For the rapid filling in of details a hand compass is sufficient, in deep soiled woods a larger instrument mounted on a jacob's staff gives more accurate results, while on roads and rocky ground a tripod is handy. The only kind of woods work for which it is not adapted is rough mountainous regions where a few high points command the territory. There some form of planetable cuts

down the expense because a network of triangulation can be built up which will locate the main features better than many miles of compass traverse. With this primary control as a basis the details can be readily filled in with the compass.

To illustrate the methods used in the determination of the area of timbered tracts take the case of a 100 acre lot as the first example. The simplest way to handle this would be to run a base line with a staff compass and chain along one side or on a convenient road or trail crossing it. Then the estimate strips could be run at regular intervals from this base line and at right angles to the principal streams. By recording the ridge tops and stream crossings on the estimate strips a very complete map may be made at very little expense in addition to the cost of the estimate itself. A larger tract of say 20,000 acres would be handled in exactly the same way except that greater pains should be taken to make sure that the framework, or primary control, was well fastened together. For this a compass would not be accurate enough. The best instrument would be a planetable with telescope alidade so that either triangulation or traverses and stadia measurement could be employed.

The relative accuracy and cost of the various methods of area determination may be summed up as follows:

Method	Accuracy	Acres per man hour	Cost per acre
	Per cent		Cents
Transit and tape	100	6	16
Transit and stadia	98	9	12
Planetable and stadia	98	12	8
Traverse board and chain	95	16	6
Staff compass and chain	95	16	6
Staff compass and pacing	92	32	3
Traverse board and pacing	90	64	2
Hand compass and pacing	90	80	1½

While this list aims at completeness in enumerating the methods employed in woodland area determination this is not the place to describe each in detail. Surveying manuals like that of Breed and Hosmer should be consulted for such information. It is sufficient for the immediate purpose to give some notion of their

comparative accuracy and cost. A tract containing 640 acres was taken in making these calculations and a unit cost of $1 per man hour assumed. Hence the cost per acre would be too low for smaller tracts. These data will, of course, be most useful in determining which method will give sufficiently accurate results at the minimum cost under any given set of conditions.

While the determination of the area is the step of first importance in valuing woodland it is far less perplexing than the decision as to the uses to which the land can most profitably be devoted. The possibility of tillage is constantly recurring even with the roughest and stoniest tracts because tillage gives the highest and quickest returns and it is the use which has the sanction of longest usage. All land can be tilled if enough labor is put on it and the idea that there are soils which will give higher net returns when used in other ways makes headway very slowly. This explains why the lumberman tries first of all to dispose of his cutover land to the farmer. Usually, however, there are only limited areas really fit for tillage in any large tract of timber. This is more particularly the case with the areas now covered with virgin timber, restricted as they are to the mountain regions and overflow lands. Few people realize how much good labor has been thrown away clearing up land which is really unfit for tillage. The abandoned farms of New England and the "sand farms" of the Lake States cutover areas are cases in point. This does not mean, of course, that there are not level stretches reasonably free from stones even in the mountains which cannot be profitably tilled. It means simply that no area can be kept in good cultivation unless it has more good soil than rocks and is not so steep that it will wash. Given these two fundamentals there are three other criteria by which it must be judged:

1. Is it subject to destructive overflow?
2. Has it good frost drainage?
3. Are markets accessible?

As has already been pointed out the overflow lands of the Mississippi are much more profitable under tillage than those of the southeastern Atlantic States because the floods in the latter region come in the middle of the growing season. It is rather the time

of flood than the actual height of the water that must be guarded against. Frost drainage is an exceedingly important point. Many mountain meadows could be made into wonderful garden spots were it not for the cold air which pours into them. But even granted that all other factors are favorable no land will be permanently remunerative under tillage unless it has ready access to markets. How near those markets must be and how smooth the intervening roads depends upon the products to be marketed. Cattle, for example, can be driven for distances and over roads that would be prohibitive for apples. All in all the experience in turning cutover land into farms has been so disappointing that the burden of proof should always be upon the would-be farmer to show that his use is the highest. In this connection it must be remembered that the returns from tillage are not so great as they are commonly painted by the real estate agent. Over a period of 25 years or more there are very few farms that give a net return of over 5 per cent. In fact the long time records of the Department of Agriculture show that 3 per cent is the average net income from farm land. The following figures are taken from such long time averages and give the net returns for some of the principal farm crops:

	Per acre per annum		
Corn	$7	Cotton	10
Wheat	6	Potatoes	7
Oats	4	Hay	4

As further substantiating this Bulletin 645, 1914, shows that the average gross farm value of the 13 principal crops of the United States was $16 an acre. This figure also holds good for Germany during the period from 1909 to 1913, while the net income was not quite $6 per acre.*

If, however, there is a comparatively small percentage of the land in forested areas fit for tillage the other agricultural use of pasturage needs to be considered even more fully. Here again there is an inherited prejudice to combat. Our ancestors depended in such large measure upon grazing for their meat, milk and hides that one naturally thinks of it as a remunerative way

to use land which is too rough for tillage. But the fundamental difficulty is that unless land is tilled at least occasionally it ceases to afford good grazing. It is only level land which has been comparatively recently turned over that will keep a cow per acre during the summer months. There must be no bare spots, stony patches, weed growth, or brush. But such land yields better under tillage so that the pasture lands are commonly those which are too rough, stony or inaccessible to plow economically. Such fields require from 5 to 40 acres per cow per season depending upon the climatic conditions. Hence at $2 per cow per month the gross return will be from $2 per acre per annum to 25 cents. As a matter of fact the Government is getting less than 10 cents per acre, gross, for its western range lands. Perhaps it is not fair to bring these arid lands into the argument because forest land has invariably a moister climate. But it must be remembered that where trees grow well they crowd out grass so that even in the moist parts of the United States no pasture takes care of itself but becomes less and less remunerative every year unless time and money are spent keeping it up. In other words pasturing is an extensive use of land which seldom gives a net return of more than $1 per acre per annum.

On every tract there are small areas which have special value for store, residence or water power purposes. Ideally, of course, these should be developed but it often happens that their fullest expansion calls for divided ownership or authority in a way that is sometimes difficult to manage. For example, a mountain lake may offer an ideal location for a summer hotel and be also valuable for hydroelectric water storage and log driving. Unless there is cordial coöperation among the interests concerned clashes of authority may arise. An unusually wise manager would be required to secure the necessary technical knowledge and yet coördinate the various activities.

The various points which need consideration with reference to the use of land for store, residence, hotel or hydroelectric purposes are itemized in " The Outline for the Examination of a Timber

* Forest Valuation. F. Roth. 1916.

Tract " given in the appendix. Those wishing to make such an examination or judge the quality of a report upon a tract are advised to consult it.

The main points witn reference to mineral deposits that can be secured in a preliminary examination are also given in this outline. Of course, no forester should presume to make a final examination of coal, iron or other mineral deposits without calling in expert advice. But on the other hand the work of the mining expert can be greatly facilitated if he can have a good map of the tract and certain general information in regard to it before starting his field work. These data the forester's examination can secure at practically no additional expense.

It is in general axiomatic that the best use to which timberland can be devoted is the production of crops of lumber or cordwood. While whatever is, is not always right, still the mere fact that a tract is forested indicates that there has been no urgent demand for it for agriculture, mining, etc. Furthermore, a change in kind of product must involve a revolution in the habits of the people who have been developing the tract and totally different kinds of technical skill in its administration. In other words, the presumption is always strong that a piece of woodland has been found by long experimentation to yield its highest returns in wood products or the by-product advantages derived from wooded areas. This is the task of the forester — to make over wild unregulated woods into forests giving their highest possible returns in lumber, cordwood, watershed protection and æsthetic values.

But naturally forestry is more profitable under some conditions than others so that the next step is to examine briefly what factors determine the income from forests and how profitable the various types of woodland in the United States and its outlying possessions may be reasonably expected to become when devoted to growing forests. As has already been explained in the chapter on Timber Valuation the main item in the cost of producing timber is not the labor or materials involved but the interest on the capital invested in the land and first cost of regeneration. It becomes necessary, therefore, to assume at the start an

interest rate. The reasons for selecting 3 per cent have already been fully discussed, so that they need not be amplified here. Second in importance is the cost of the land itself and three values have been chosen, $5, $10 and $15 per acre, for this discussion. The cost of regeneration is assumed to be $10 per acre and the annual charges for administration and protection, $1 per acre. Rotations of 50, 100 and 150 years will be considered and final yields of 250, 500 and 1000 board feet per acre per annum. A uniform stumpage price of $10 per M has been used in the calculations because it seems reasonable to assume that this will be an average figure for all species by the end of a rotation of 50 years. Stumpage prices in the United States range from $1 to $20 per M with the average considerably under $10 but we are fast approaching European conditions where even low grade softwood is bringing $10 per M and high grade hardwood four or five times that. In this connection it is interesting to note that Kellogg and Zeigler came to the conclusion in 1911 after a study of American growth and market conditions that $10 per M was a fair estimate of the average cost of timber production. No allowance was made for either returns from thinnings or accelerated growth as a result of such thinning in order to have an ample margin with which to offset possible losses from fire, insects and fungi. That this margin is more than sufficient will appear clearly when it is considered that annual charges of 50 cents per acre are allowed for protection and administration. While this is not large as measured by European standards it is much greater than has yet been expended over any considerable area in the United States. The National Forests, for example, are administered and protected for less than five cents per acre, but the Forest Service appropriation is so inadequate that only the merest beginning has been made.

Three yields have been used, 250, 500 and 1000 board feet per annum. The first gives negative values even under the most favorable conditions so that the following types may be ruled out at once as unremunerative from the standpoint of timber production:

Northern swamp type.
Southeastern ridge type.
Chapparal type.
Pinon-juniper type.
Western yellow pine on semi-arid sites.

While these types are too slow growing to make it worth while to raise timber on them they usually have secondary uses which justify their being kept wooded.

An average yield of 500 board feet per annum includes a larger number of types. While this may seldom be found under virgin conditions in the following types it is obtainable under management:

Northern spruce.
Northern hardwoods.
Cove.
Slope.
Southern pine.
Western yellow pine on moist sites.
Lodgepole pine.
Engelmann spruce.
Sugar pine.

These lands will yield good returns with rotations of less than 100 years. In other words, they can be profitably employed for the production of ties, pulpwood and boxboards but they will not grow large sized sawtimber.

In fact it is only the types of timberland which will yield at the rate of 1000 board feet per acre per annum on which large sized sawtimber may be profitably grown. Fortunately these are scattered rather evenly thruout the United States. In the northeast there is the white pine type. The southeast has the overflow bottomlands. Only the Rocky Mountain region has too severe a climate to permit such rapid growth. In the Pacific northwest there are the silver pine, cedar flat, Douglas fir, and redwood types.

The length of rotation is an exceedingly important item be-

cause it not only sets the period of interest accumulation but determines the final yield. Generally speaking it takes about 50 years under favorable conditions to grow boxboards, pulpwood and railway ties, 100 years to produce ordinary sawtimber, and 150 to 200 years are required for extra wide clear finishing lumber. Roth gives the following rotations for the principal European species:

Pine and spruce.....	80 to 100 years in public forests.
Pine and spruce.....	60 to 80 years in private forests.
Balsam.....	100 years
Beech.....	100 to 120 "
Oak.....	150 to 200 "

It is obvious, therefore, that types which cannot produce railway ties at least in 100 years are hopelessly handicapped. Consequently the slower growing types such as the northern swamps, southern ridges, western yellow pine on semi-arid sites, chapparal and pinon-juniper types cannot justify themselves as wood producers no matter how long the rotation. Conversely, the types with rapid annual growth are not only the most productive for short rotations but are also the only ones that will pay dividends from timber production alone if left for over 100 years.

Land values in forestry must obviously be low. Interest must run for long periods and high priced land would soon accumulate amounts of interest which even the most rapid growth could not offset. Furthermore it is fundamental that forests should be restricted to the low priced, stony, rough lands unfit for tillage. Therefore, the values used, $5, $10 and $15, err on the side of conservatism rather than being too low. In this connection it is interesting to note that $15 per acre is the average value at which the British Reforestation Committee estimate — 1918 — they can secure land in the British Isles. The purchases by the Federal Government under the Weeks Law have never exceeded $5 an acre for the land itself. The land value and the compound interest which it accumulates are not determining factors in deciding where forestry may be profitably practised. Any low priced land which has favorable climatic and soil conditions for rapid growth will give good returns if forested.

The cost of regeneration is like the value of the land, an important but not a determining factor. It must be considered not so much on account of the first cost as by reason of the accumulated interest in a long rotation. Naturally it varies within wide limits. Where artificial regeneration is necessary the cost per acre may easily exceed $15, but there are many, many instances in which natural regeneration may be relied upon for a satisfactory stand at a cost much less than would be required if the young trees were sown or planted. Ten dollars an acre, before the Great War, was an average figure for the cost of planting and it has been used in these calculations since it represents very fairly a mean between the sites where natural seeding will give good results and those less favorable sites which can only be regenerated artificially. It is certainly fair to say that $10 an acre will secure a satisfactory reproduction in all stands where the climatic conditions are at all favorable to forest growth.

Taking all the factors into consideration, both costs and receipts, it is evident that what determines the profit from forest investments is the yield. In other words, types in which the yield is below 500 board feet per acre cannot be expected to be kept forested unless the tree growth is valuable for other purposes than wood production. Or expressed differently, our sawtimber will in the future be produced in the following types:

White pine.
Southern bottomlands
Silver pine.
Redwood.
Douglas fir.
Cedar flats.

For the production of ties, pulpwood and boxboards the following types in addition to those listed above are suitable under favorable conditions:

Northern hardwood.
Northern spruce.
Southern pine.
Southern Appalachian coves.

Southern Appalachian slopes.
Western yellow pine on moist sites.
Lodgepole pine.
Engelmann spruce.
Sugar pine.

It will be noticed that these lists do not make any reference to the raising of large sized hardwoods. It is true that wide, clear boards of oak, ash, cherry, etc., cannot be grown profitably with a stumpage price of $10 per M. What has happened in Europe and will unquestionably happen here is that the stumpage prices of high grade hardwood will go above $10. For 200 year oak $50 per M has been paid in Germany.

CHAPTER XXIII

TITLES

There are certain legal difficulties in securing sound titles to woodland tracts which make the subject of special interest to all woodland owners, present and prospective. Briefly stated these are due to two factors. In the first place woodlands in the United States have not been of great value in the past so that their owners have neglected to have them properly marked and described. In the second place, and of even more importance, the definition of acts of possession is vague so that there is no general agreement as to what an owner must have done to prove conclusively that he owns a tract.

A tract of land may be marked in various ways. The commonest method is by fences, either of rails, stones or wire. But large tracts of woodland are seldom fenced on account of the expense of fencing as compared with the advantages of preventing grazing. It is usually cheaper in a woodland grazing country to fence the relatively small areas of tilled and cleared land and let the stock roam at will. Should an owner desire to prevent grazing trespass in a community of this kind the entire burden of such an innovation would be upon him. His neighbors would give him neither legal protection nor sympathy. Such primitive communities think of the woods first of all as a common pasturing ground and cannot be expected to have developed a sense of private property rights in timberland. In fact the use of woodland for forest production is much more recent historically than the pasturage use and runs counter therefore to many inherited prejudices dating back to the time when the woodlands were used in common for grazing and what little timber and firewood a primitive community needs. Even the development of private rights to the timber does not break down the feeling of common ownership in pasturage. Consequently, it is rare that woodlands are

marked except by monuments at the lot corners and blazed lines in between the corners even aside from the expense of fencing. Unfortunately, too, these monuments are often of the flimsiest character and the blazes carelessly done and only renewed at rare intervals.

As a result of the low regard for private interests in woodland the old descriptions are crude and hazy in the extreme. A grant of thousands of acres may be tied to "a white oak post situated on the ridge between" two creeks. When the post rots the tract is suspended in air. This has actually happened in many cases. For example, the Government's title to the famous Olmsted tract in North Carolina hung upon the location of a stake all traces of which had disappeared in 40 years. The testimony of local inhabitants as to where they had heard that it had been was the best evidence that could be found to relocate the starting point. Courses, too, may be as vague. Even when stated in degrees, and not vaguely as "westerly, northerly," etc., there is often grave reason for questioning the accuracy of the instrument used or the skill of the surveyor. Open sight staff compasses are the most accurate instruments usually employed in such work so that the declination and local attraction must always be considered in determining the present bearing from an old reading. What still further complicates the retracing of old descriptions is that the distances are frequently either vague or inaccurate, i.e., they may be given as approximately a fraction of a mile, measured on the surface without allowance for slope, or so carelessly done that large errors have been made. As a consequence the areas given for tracts of rough woodland are seldom within 10 per cent, always the saving phrase "more or less," is added in stating the acreage. In fairness to the old surveyors it should, however, be said that the areas usually overrun. In other words, their estimates, and they are frequently little less, have the virtue of conservatism.

Nothing that has so far been said should be construed as advising undue accuracy in woodland surveying. The values per acre do not justify city survey methods. All that is needed is reasonable definiteness in locating tie points, and reasonable accuracy

in measuring angles and distances. To make this more concrete every survey should be tied to a United States Geological Survey or United States Coast and Geodetic Survey bench mark, a General Land Office section corner, or a railroad, stream, or road crossing. Practically speaking these are the only points which are located with sufficient definiteness. As for the measurement of angles the compass is and will remain the most convenient instrument for woods work. It simply needs to be used with a recognition of its limitations. Distances may be measured by tape, stadia, chain or pacing, but they should always be reduced to the horizontal and the method employed stated. The map resulting from such field work should show all the principal streams, lakes, ponds, roads, trails and property lines. Preferably it should also show the topography by contours. It is a great help, for example, to know what the slope is like near an important corner for which one is searching.

The cost of such mapping varies, naturally, with the methods employed. The following data will be helpful in estimating such costs:

Method	No. in crew	Cost of field work. Average daily wage including board	Cost per day	Miles in 8 hours	Cost per mile
		Per Day			
1. Transit and tape.....	7	$4	$28	2	$14
2. Transit and stadia.....	5	$4\frac{1}{2}$	22	3	$7\frac{1}{3}$
3. Compass and chain.....	4	$3\frac{1}{2}$	14	6	$2\frac{1}{3}$
4. Compass and pacing....	2	4	8	8	1

The office work — drafting and area computation — would not be essentially different for the various methods and ought not to exceed one cent per acre.

Expressed on an acreage basis the cost of such boundary surveys vary from one cent to one dollar per acre. The Federal Forest Service has been making transit and tape surveys of the lands purchased under the provisions of the Weeks Law for 23 cents per acre in 1918 including the office work of map preparation, area computation by latitudes and departures, and considerable legal investigation necessary to the determination of the location of the tracts to be surveyed.

As already stated the question of determining the rightful claimant to a piece of woodland is much more difficult than in the case of farmland. A man who owns a farm either lives on it, rents it or manages it thru an agent. He must fence it, cultivate it and keep the buildings in repair. It is a matter of common knowledge who the real owner is. None of these acts of possession are necessary in the case of woodland. Even paying the taxes and cutting the timber have been held to be no sure indication of ownership. Nor should they be because many lots have been cut illegally and taxes have been paid in many cases merely to acquire color of title. For example, there have been a number of notorious cases of woodland theft in northern New England in which the title of the illegal claimant was based on a quit claim deed supported by tax receipts. The quit claim deeds were secured at a nominal figure from persons who had never seen the land, much less owned it. In order to cover up all traces of wrong doing and weaken the case of the rightful claimants the county records were often wilfully destroyed. The point of all this is, of course, that acts of possession have nowhere near the same force with reference to woodland as with other forms of real estate. It is, therefore, all the more necessary for the woodland owner to make sure that every proper act of possession is carefully put on record. This would mean filing a careful description and map in the County Clerk's Office, renewing the monuments and blazes, keeping up taxes, and curbing all forms of trespass.

The mere fact that there is uncertainty as to what constitutes an "act of possession" with reference to woodland makes a title search all the more necessary. Both the owner and prospective purchaser need to know whether there are rival claimants, and this only a thoro search of the local legal records will give. The Department of Agriculture in its investigations of the titles offered for purchase under the provisions of the Weeks Law has set a standard for such work. They try to secure for each deed or mortgage the following information:

1. Kind of conveyance, date, date and place recorded and volume and page.
2. Name and address of vendor.

3. Name and address of vendee.
4. Consideration.
5. Description.
6. Reservations and limitations.
7. Habendum.
8. Covenants.
9. Dower, curtesy and homestead rights
10. Signature.
11. Witnesses.
12. Acknowledgment.

The marital status of the grantor should be ascertained where the state laws make it of material weight. For example, in most states no married man may give a valid deed without being joined therein by his wife. Deeds are, of course, filed in the County Recorder's Office at the county seat.

The records of the probate court are also kept in the county court house, usually in conjunction with the deeds. These records differ somewhat depending upon whether the owner of land made his own will or died intestate. In the former case the following points should be covered in the title search:

1. Execution of the will.
2. Names of witnesses.
3. Exact description of property devised.
4. Name of each devisee.
5. Date and location of probate.
6. Notice to creditors and other interested parties.
7. Proof of service.
8. Final disposition of property.
9. Discharge of administrator.

Where no will was made and the probate court appointed an administrator the essential points to be noted are:

1. Appointment and qualifications of administrator.
2. Names of surviving relatives.
3. Notice to creditors.
4. Date and proof of service.

5. Application for order of sale with date.
6. Confirmation of sale with date.
7. Discharge of administrator.

Partition of estates by guardians or trustees present certain special points. These are listed below:

1. Location (venue).
2. Names of parties.
3. Property described in petition.
4. Notice and proof of service.
5. Order of reference and report.
6. Order of disposition.
7. Final decree.

Condemnation proceedings form part of the regular court records but the county recorder will be able to give anyone interested access to the proper papers. The following points should be looked up:

1. Location of proceedings (venue).
2. Name of parties.
3. Date of declaration or complaint.
4. Cause of action.
5. Date of service on defendant and kind of service.
6. Date of answer and allegations therein.
7. Material orders of court and final decree, with dates.
8. Final disposition of case, with date.

Data in regard to forced sales is kept by different officials in different parts of the country. In New England where the town is the unit of government the town clerk keeps the records of tax sales. In the other thirteen original states the county sheriff handles such executions while the United States Land Commissioner is the custodian of tax sale data in the land grant states.

The final report, or abstract of title, should consist of a history of the title including a complete list of all owners or claimants for the period covered together with the opinion of the examining attorney as to its validity. It would naturally be accompanied

by copies of all the papers examined in working up the case and maps which show not only the present boundaries of the tract but also the lots and grants of which it is composed.

Anyone who has followed the discussion of titles so far must have been impressed with the great amount of local knowledge required. For this reason it is better to employ local attorneys and surveyors where they can be trusted to do the work with sufficient accuracy. Unfortunately, however, they are too often poorly trained so that a more skilled man must be employed to superintend their efforts. But local knowledge of the families, grants, lot lines and topography must be secured at whatever cost. The Federal Government has adopted the practice of securing trained men by a civil service examination and then sending them directly out into the field to acquire local color.

By all odds the most difficult titles to investigate are those of lands lying in the thirteen original states. Not only are these states older so that there have been a greater number of property transfers but, worst of all, the land subdivisions are poorly marked. Where the section a mile square is the unit and the land is divided into townships the process of description and identification is very much simplified. Compare, for example, the process of finding the S W ¼ Sec 15, T 14 N R 16 W, Montana Principal Meridian, with a tract 160 acres in extent and forming a part of a grant whose initial point established 100 years ago is a stake and stones on a ridge between two obscure creeks. Fortunately, even some of the original thirteen states adopted a lot system. This helps immensely even tho there may be no uniformity between states or parts of the same state as to the size of the lots and the direction of their boundary lines. But where the state land departments adopted a policy of selling any sized grant to any purchaser and put entirely upon him the burden of finding out whether there was any such unclaimed land, inextricable confusion arose. As has already been pointed out the land grants in certain parts of North Carolina are two or three deep. A man may have purchased a patent to 10,000 acres but be unable to find more than 500 after all the prior patents are taken out. In general it may be said that land identi-

fication, land description and title abstracting is easily five times as expensive in the thirteen original states as compared with work of the same quality in the states which are divided up into townships. Naturally the cost per acre varies within wide limits but it may be of interest to know that the title investigations on 1,000,000 acres in Maine, New Hampshire, Virginia, North Carolina, South Carolina, Georgia and Pennsylvania cost the Department of Agriculture 17 cents per acre in 1918.

CHAPTER XXIV

OUTLINE FOR A REPORT ON A TRACT OF WOODLAND

Summary and recommendations.

Total amount and value of:

Timber.

Land.

Other products (minerals, waterpower, residence sites, etc.).

Grand total value.

Total value per acre.

Best future use of tract.

Estimated annual returns.

Total annual returns.

Total annual returns per acre.

Title complications.

Object of examination.

Valuation of tract.

Formulation of logging plans.

Preparation of a working plan for the future development of the property.

Location, area and general description.

Town (postoffice if different), county, state, watershed.

Nearest railway and road.

Area in acres (illustrate by map).

Form — scattered lots or contiguous tracts (illustrate by map).

Subdivisions — legal and natural (illustrate by map).

Climate.

Total annual precipitation and mean annual temperature of nearest U. S. Weather Bureau station.

Estimated annual precipitation and mean annual temperature for tract.

Frost drainage of tract.

Topography (illustrate by a map).
- Principal watersheds.
- Principal mountains or hills.
- Geological history of region.
- Geological map if possible.
- Distribution of soil types.
- Soil map if possible.

Settlement (illustrate by map).
- Nearest towns or villages.
- Population per square mile of general region and particular being examined.

Timber.

Amount — total stand by species and subdivisions of tract (table).

Quality and market value by species and products (table)
- Damage from fire, insects and fungi.

Cost of logging and manufacture for market.
- Lumber — felling and bucking, brush disposal, skidding, hauling, milling, seasoning, selling and profit.
- Other products — cost of steps in manufacture.
- Logging plan (illustrate by map).

Stumpage values by species and subdivisions.
- Table.

Growth — best species; reproductive capacity; estimated yield per acre per annum in cubic feet and dollars, probability of damage from fire, insects, fungi, trespass, etc.

Land.

Amount by quality classes (table):
- Tillage land.
- Grazing land.
- Forest land.
- Areas suitable for other purposes.
  - Hydroelectric purposes:
    - Location of reservoirs, dams, power houses, etc.
    - Estimated cost of development.
    - Estimated horse power to be developed and its value.

Residences and stores:
Number and location.
Annual rentals.

Recreation:
Number and location of hotels.
Estimated cost and returns.
Fishing and hunting possibilities.

Minerals:
Kinds, quality, and approximate location.
Development work on this and adjoining properties.

Value by quality classes (table).

Estimated returns per acre per annum from use for:
Agriculture (tillage and grazing).
Forest production.
Hydroelectric purposes.
Stores or residences.
Recreation — hotels, fishing and hunting.
Mining

Titles.
Legal history of tract.
Kind of titles.
Doubtful lots and their legal defects.
Local authorities and witnesses:
Attorneys.
Surveyors.
Guides.

List of maps.— Maps can best be made on the same size paper as the rest of the report even if this necessitates making more maps or reducing the scale for special large area maps and using an enlarged scale for small area maps. Several maps of workable size are better than one large map which attempts to show all the essential features. What can be advantageously combined in one map differs from tract to tract but the tendency is always to try to economize and put too much on one map.

Area, form and subdivision map.

Topographic map — preferably with contours, streams and ridges.
Geological map — geological formations.
Soil map — soil types.
Settlement map — principal settlements, railroads, roads and trails.
Timber type map.
Timber stand map.
Logging plan map — location of roads, drivable streams, camps, mill sites, etc.
Land type map.
Hydroelectric map — development plan showing reservoir and power-plant sites — detail maps of important features.
Residence and store location map.
Recreation map — hotel sites, fishing and hunting grounds, trails, roads, etc.
Mineral map — mineralized areas, development locations, trails, roads and railroads.

Photographs should be taken to illustrate the following features:

Topography.
Geological structure.
Settlement.
Timber types, quality, damage, and growth.
Logging developments — roads, camps, driving dams, mill sites, local logging methods and equipment.
Land types — local agricultural methods and equipment.

Hydroelectric development possibilities:
Proposed reservoir and power sites.
Residence and store locations and local types.

Recreation possibilities:
Hotel sites kinds of game and fish.
Local mining developments.

Diagrams illustrating the following points may often be employed to advantage:

Cross sections of topographic features.

Geological structure.
Relative timber growth by species and types.
Relative value by timber species and types.
Relative value of land types.
Relative incomes and capital investment from various types of development.

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