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NINETEENTH ANNUAL REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY,

CHARLES D. WALCOTT, DIRECTOR.

PART V.

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NINETEENTH ANNUAL REPORT

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UNITED STATES GEOLOGICAL SURVEY

PART V—FOREST RESERVES

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DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., July 18, 1898.

SIR: I have the honor to transmit herewith, for publication as a part of the Nineteenth Annual Report, a collection of papers and reports descriptive of the forests of the West, especially of certain of the forest reserves created by Executive order of President Cleveland of date February 22, 1896.

Very respectfully,
HENRY GANNETT,
Geographer.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

FOREST RESERVES.

HENRY GANNETT, *Chief of Division.*

THE FORESTS OF THE UNITED STATES.

The woodland and forests may be considered from two points of view, (*a*) as a source of lumber supply, and (*b*) as a physical factor with effects upon climate, erosion, and the flow of streams.

As a source of lumber supply the forest is, to all intents and purposes, an agricultural crop, differing from most other agricultural products in the fact that it requires a long time to reach maturity—generations—while other crops require only months or, at most, a few years. The forests of the United States consist in part of what is commonly called original growth—which means simply that the forest is composed in the main of old trees which have, by sufferance of fire and the ax, been permitted to reach or exceed maturity—and in part of young growth of various ages, covering regions which have been either wholly or partially cleared by fire or the ax. The former areas bear a mature crop, the latter a crop in process of growth; thus the forest is constantly restoring itself in all those regions where the rainfall is sufficient to encourage tree growth; and in time, if not interfered with, these regions will furnish a supply of lumber as large, and presumably of the same quality, as that available when settlement first invaded them. Hence, the timber supply of the country is, in a sense, a continuous one. Timber is constantly growing to supply that which is used, and in this respect it differs from our supplies of iron ore, coal, and other minerals. These, when exhausted, will never be replaced.

The study of the forests of this country has been carried on almost entirely upon the botanical side. Our forests have been studied thoroughly and exhaustively by botanists, but the geographic and economic sides of the question have received very little attention, except for purely commercial or utilitarian purposes. Even such an elementary fact as the extent of woodland in this country we know only in a broad, general way, except for certain limited areas which have been mapped in connection with topographic surveys. Of the amount of standing timber available for our use we know almost nothing. In view of the agitation for the protection of our forests which has been going on for at least a generation, and which has reached such intensity that it has become with many persons almost a religion, it is strange that there should be practically no knowledge to serve as a basis for such a cult.

In the following pages I propose to set forth the best estimate which, so far as I can see, it is possible to make at present of the woodland in this country, with its distribution by States. The sources of information will be given in such a way as to show their degree of reliability. I shall follow this with a summary of the little information we have regarding the quantity of timber, including all estimates with which I am acquainted that appear to be worth republishing; and as certain of these estimates concern the same area and the same species of timber and differ greatly from one another, I wish to say at the outset that the conflicting estimates are not published for the purpose of criticism, but simply to show that the best of available estimates do not agree and must be accepted with reservations.

We know in a broad way that the eastern part of the country, extending from the Atlantic coast to the prairies, is naturally a forested region, owing to the fact that rainfall is sufficient to encourage the growth of trees. Throughout this region the only areas not forested at present are those which have been cleared by man, and most of these are under some form of cultivation. Wherever the land is left waste, forests reproduce themselves. Upon the prairies and the plains and in the Rocky Mountain region trees grow wherever the climate will permit—i. e., wherever the rainfall is sufficient for their needs, and as rainfall is greater upon the mountains than upon the plains and in the valleys, timber is commonly found upon the mountains. On the other hand, on the northwest coast, where the rainfall is ample, and in some cases excessive, the country is heavily forested.

WOODED AREAS, BY STATES.

The wooded area of the country—the area upon which the timber crop is growing—is a subject of interest and importance, whatever may be the stage of growth of the timber upon it.

Concerning the areas upon which timber is at present growing, we are in position to make certain definite statements, although we know the entire area only approximately. Over large parts of the country the topographic maps prepared by the Geological Survey show the extent of woodland with a high degree of accuracy. The Hayden, Wheeler, and Powell surveys of the Western States and Territories mapped the woodlands over other large areas. The Northern Transcontinental Survey, carried on by the Northern Pacific Railroad Company, and the Northern Pacific Railroad Company itself have mapped considerable areas in the State of Washington. California, through its forestry commission, has similarly mapped the forested areas in the northern part of the State. From these sources the timbered areas of Massachusetts, Rhode Island, Connecticut, New Jersey, Kansas, Colorado, Utah, and parts of other States have been depicted in detail.

In most of the Eastern States, which are naturally forested, a close approximation to the wooded areas has been obtained from the figures of the Tenth and later censuses. These give the total land area, the area included in farms, and, of the area included in farms, the woodland. The item of woodland given in these statistics does not include waste or brush land, but only that properly classified as woodland. It is assumed that the area not in farms is, in these States, composed of woodland, an assumption which is for most of these States substantially correct, and for those States where it is not true, allowance has been made for the area naturally devoid of timber. In the States of the prairie, plains, and Cordilleran regions, for which this assumption is incorrect, other means of obtaining the timbered areas have been used, as set forth in the detailed account following:

MAINE.

The area of woodland has been obtained from the census of 1880.

	Sq. miles.
Total land area	29,875
Woodland in farms	4,200
Woodland not in farms	19,500
Total woodland	23,700

Percentage of land area, 79.

NEW HAMPSHIRE.

The area of woodland has been obtained from the census of 1880.

	Sq. miles.
Total land area	9,005
Woodland in farms	2,000
Woodland not in farms	3,200
Total woodland	5,200

Percentage of land area, 58.

VERMONT.

The area of woodland has been obtained from the census of 1880.

	Sq. miles.
Total land area	9,135
Woodland in farms	2,300
Woodland not in farms	1,600
Total woodland	3,900

Percentage of land area, 43.

MASSACHUSETTS.

The area of woodland, 4,200 square miles, or 52 per cent of the land area of the State, has been obtained from the maps of this Survey.

RHODE ISLAND.

The area of woodland, 400 square miles, or 40 per cent of the land area of the State, has been obtained from the maps of this Survey.

CONNECTICUT.

The area of woodland, 1,900 square miles, or 39 per cent of the land area of the State, has been obtained from the maps of this Survey.

NEW YORK.

The area of woodland has been obtained from the census of 1880.

	Sq. miles.
Total land area	47,620
Woodland in farms	8,100
Woodland not in farms	10,600
Total woodland	18,700

Percentage of land area, 39.

NEW JERSEY.

The area of woodland has been obtained from the maps of the State survey. Wooded area, 3,234 square miles, or 43 per cent of the land area of the State.

PENNSYLVANIA.

The area of woodland has been obtained from the census of 1880.

	Sq. miles.
Total land area	44,985
Woodland in farms	9,100
Woodland not in farms	14,100
Total woodland	23,200

Percentage of land area, 51.

DELAWARE.

The area of woodland has been obtained from the census of 1880.

	Sq. miles.
Total land area	1,960
Woodland in farms	440
Woodland not in farms	260
Total woodland	700

Percentage of land area, 36.

MARYLAND.

The area of woodland has been obtained from the census of 1880.

	Sq. miles.
Total land area	9,860
Woodland in farms	2,550
Woodland not in farms	1,850
Total woodland	4,400

Percentage of land area, 44.

DISTRICT OF COLUMBIA.

The wooded area has been measured from the maps of the U. S. Coast and Geodetic Survey at 12 square miles.

VIRGINIA.

The area of woodland has been obtained from the census of 1880.

	Sq. miles.
Total land area	40,125
Woodland in farms	14,300
Woodland not in farms	9,100
Total woodland	23,400

Percentage of land area, 58.

WEST VIRGINIA.

The area of woodland has been obtained from the census of 1880.

	Sq. miles.
Total land area	24,645
Woodland in farms	9,700
Woodland not in farms	8,700
Total woodland	18,400

Percentage of land area, 74.

NORTH CAROLINA.

The area of woodland has been obtained from the census of 1880.

	Sq. miles.
Total land area	48,580
Woodland in farms	21,700
Woodland not in farms	13,600
Total woodland	35,300

Percentage of land area, 72.

SOUTH CAROLINA.

The area of woodland has been obtained from the census of 1880.

	Sq. miles.
Total land area	30,170
Woodland in farms	11,300
Woodland not in farms	9,200
Total woodland	20,500

Percentage of land area, 68.

GEORGIA.

In the reports upon cotton production of the census of 1880 there are statements of the wooded area of each county in the States of Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arkansas, and Tennessee. They were obtained with considerable care by Prof. Eugene Hilgard and his assistants. In the case of Georgia, each county is reported to be naturally entirely woodland. The wooded area has therefore been accepted as given by the census, without change.

	Sq. miles.
Total land area	58,980
Woodland in farms	23,800
Woodland not in farms	18,200
Total woodland	42,000

Percentage of land area, 71.

FLORIDA.

In the description of the counties of this State in the report upon cotton production, above cited, it is stated that an area of 14,760 square miles is devoid of timber. This is comprised almost entirely in the southern portion of the peninsula. The census figures for woodland, obtained in the manner above described, have therefore been reduced by this amount, leaving a timbered area of 34,300 square miles, or 70 per cent of the area of the State, as follows

	Sq. miles.
Total land area	54,240
Woodland in farms	3,400
Woodland not in farms	34,300
Total woodland	37,700

Percentage of land area, 70.

ALABAMA.

In this State the counties are reported as being composed entirely of woodland, and no reduction is therefore made from the census figures.

	Sq miles.
Total land area	51,540
Woodland in farms	16,300
Woodland not in farms	22,000
Total woodland	38,300

Percentage of land area, 74.

MISSISSIPPI.

In this State Professor Hilgard reports that 3,600 square miles are naturally open country. While some of this area, perhaps a considerable part of it, may have been reduced to cultivation, appearing in the census reports as improved land, still the entire amount has been deducted from the census figures, leaving a timbered area in the State of 32,300 square miles, or 70 per cent.

	Sq. miles.
Total land area	46, 340
Woodland in farms	14, 300
Area not in farms	21, 600
	35, 900
Open areas not in farms	3, 600
Total woodland	32, 300

Percentage of land area, 70.

LOUISIANA.

In this State Professor Hilgard reports 11,300 square miles of naturally open country. This is mainly in the southern counties, bordering the Gulf. It has been deducted from the census figures, leaving 28,300 square miles of woodland, or 62 per cent of the area of the State.

	Sq. miles.
Total land area	45, 420
Woodland in farms	7, 100
Area not in farms	32, 500
	39, 600
Open country not in farms	11, 300
Total woodland	28, 300

Percentage of land area, 62.

TEXAS.

The total land area of Texas is 262,290 square miles. The areas of woodland in the central and western portions of this State have been measured from the maps of this organization. Other timbered regions, all of which are comprised in the eastern part of the State, have been taken directly from the reports upon cotton production above cited, giving the total wooded area of the State at 64,000 square miles, or 24 per cent of its area.

ARKANSAS.

In this State the reports upon cotton production give the area of naturally open country at 1,500 square miles. The census figures have therefore been reduced by this amount, leaving a timbered area of 45,000 square miles, or 84 per cent.

	Sq. miles.
Total land area	53, 945
Woodland in farms	12, 300
Area not in farms	34, 200
	46, 500
Open country not in farms	1, 500
Total woodland	45, 000

Percentage of land area, 84.

KENTUCKY.

In Kentucky the census method has been employed.

	Sq. miles.
Total land area	40,000
Woodland in farms	15,800
Woodland not in farms	6,400
Total woodland	22,200

Percentage of land area, 55.

TENNESSEE.

In Tennessee the census method has been employed, since the cotton reports specify that the counties are all naturally covered with timber.

	Sq. miles.
Total land area	41,750
Woodland in farms	17,600
Woodland not in farms	9,700
Total woodland	27,300

Percentage of land area, 65.

OHIO.

With the exception of 2,460 square miles, or about 6 per cent, the entire area of Ohio was included in farms. The woodland in farms was reported at 9,300 square miles. The area not included in farms is little more than is necessary to allow for roads, right of way of railroads, and the areas of cities. The area of woodland in farms, therefore, may be regarded as a close approximation to the total wooded area of the State. This is about 23 per cent of its area.

INDIANA.

The area in farms in this State is approximately 32,000 square miles, leaving only 3,900 square miles not included in farms. Of this, probably about 1,000 square miles are occupied by roads, railroads, and town sites, leaving 2,900 square miles. Much of this is in the southern part of the State, which is better timbered than the northern part, and it is believed that certainly half of this land is wooded. This, added to the woodland in farms, 9,300 square miles, makes a total of 10,800 square miles of timber land in the State, or 30 per cent of its area.

ILLINOIS.

The land area of Illinois is 56,000 square miles. Of this, 49,500 square miles are included in farms, leaving 6,500 square miles to be accounted for. The southern portion of the State is well timbered, and the greater part of the area not in farms is found in these southern counties. After allowing 1,500 square miles for roads, railroads, and town sites, it is believed that one-half the remainder, or 2,500 square miles, is timbered, and this, added to the 7,700 square miles of woodland in farms, makes 10,200 square miles as the entire wooded area of the State, or 18 per cent.

MICHIGAN.

In this State we have the returns from the census of 1894. At that time the southern portion of the State, in which all the prairie land is situated, was almost entirely taken up in farms, the upper portion of the lower peninsula and the entire upper peninsula, except where improved, being woodland. The entire land area of the State is 57,430 square miles. The woodland in farms was 4,600 square miles; the entire area in farms was 23,900 square miles, leaving 33,530 square miles as woodland not in farms. This, with the woodland in farms, makes a total for the State of about 38,000 square miles, or 67 per cent of the area of the State.

WISCONSIN.

Land area, 54,450 square miles. For this State we have the State census for 1895, showing a total area in farms of 28,700 square miles, which, subtracted from the total area of the State, leaves 25,750 square miles, practically all of which is timbered land. This, added to the timbered area in farms, 6,000 square miles, makes 31,750 square miles of woodland in the State, or 58 per cent of its area.

MINNESOTA.

The census figures for 1880 in this State are inadequate to express its present condition, inasmuch as at that time large tracts of prairie land in the southern part were not included in farms. The census of the State, taken in 1895, does not give farm areas, but the State Geological and Natural History Survey has made an estimate of the timbered area, which is, I believe, entitled to confidence, and has been accepted. This gives the timbered area of the State as 52,200 square miles, or 66 per cent of its area.

IOWA.

Land area, 55,475 square miles. This is essentially a prairie State, containing but little timber, and that scattered in small areas over its surface. The figures of the census of 1880 can not be used, as in other States, inasmuch as at that time large areas of prairie land were not included in farms. Judging from the small portion of the State which has been mapped by the Geological Survey, and a certain amount ot local knowledge, it is estimated that about one-eighth of the State, or say 7,000 square miles, consists of woodland.

MISSOURI.

Within this State the transition occurs from dense forests, which cover the southeastern portion, to prairie lands in the northwest. North of Missouri River the country is largely prairie, the proportion of prairie increasing westward. South of the river the eastern portion of the State is naturally entirely forested, the proportion of forest diminishing in the western part until along the west boundary not more than 20 to 30 per cent is naturally forested.

About one-fourth of this State has been mapped by this organization, being the central and southwest portions. The maps show this progressive diminution of timber, and, so far as they go, the distribution of woodland. Using them as the basis of an estimate for the State, a result was obtained which accords very closely with the results obtained from the census of 1880, and this has been adopted. It is as follows:

	Sq. miles.
Total land area	68,735
Wooded area in farms	15,800
Woodland not in farms	25,200
Total wooded area	41,000

Percentage of land area of the State, 60.

NORTH DAKOTA.

This State contains only a trifling amount of woodland, located in the valley of Missouri River, about Devils Lake, and in the Pembina Mountains. The total area is estimated at 600 square miles, or about 1 per cent of the area of the State.

SOUTH DAKOTA.

The main body of timber in this State is in the Black Hills, in the southwestern portion. A narrow strip occurs also along Missouri River and other large streams. The area of timber in the Black Hills is taken from the maps of this organization, and covers 2,000 square miles, to which may be added 500 square miles as the area in the bottom lands of the streams, making a total of 2,500 square miles, or 3 per cent of the area of the State.

NEBRASKA.

The wooded portion of Nebraska is in the extreme eastern portion of the State, and is estimated at 2,300 square miles, or 3 per cent of the State's area. A large body of pine timber is reported in the northwestern part of the State, but its area and limits are unknown.

KANSAS.

The wooded area of Kansas is in the eastern portion of the State. It is narrow in the north and broadens southward. It has been mapped by this organization, its area being 5,700 square miles, or 7 per cent of the State's area.

INDIAN TERRITORY.

The wooded area of the Territory covers 20,000 square miles, or 65 per cent of its area. This area is obtained from maps and plats of the Territory. Nearly all of the Choctaw Nation, part of the Creek Nation, the eastern portion of the Cherokee Nation, and about half of the Chickasaw Nation are woodland.

OKLAHOMA.

The wooded area of Oklahoma is taken, in the main, from the maps of this Survey, which indicate that it comprises 4,400 square miles of the eastern portion of the Territory, or 11 per cent of its entire area.

MONTANA.

Of the area of Montana it is estimated that 42,000 square miles, or 29 per cent, are wooded. In obtaining these figures the maps of this organization, covering much of the western portion of the State, were used. The remaining timbered portions were outlined from local knowledge possessed by men in this office, particularly Mr. J. B. Leiberg.

WYOMING.

The timbered area of Wyoming is estimated at 12,500 square miles, being 13 per cent of the area of the State. This estimate was obtained from the maps of this organization, covering the Bighorn Mountains and Yellowstone Park and the adjacent forest reserves, and the Hayden map of the southwestern portion of the State, supplemented in other regions by local knowledge possessed by topographers of the Survey.

COLORADO.

The wooded area of Colorado is 33,500 square miles, or 32 per cent of the area of the State. This was taken from the surveys made by the Hayden Survey in 1872 to 1876.

NEW MEXICO.

The wooded area of New Mexico is estimated at 23,700 square miles, or 19 per cent of the area of the Territory. This was obtained from the maps of this Survey and of the Wheeler Survey, supplemented by local knowledge possessed by men in this office.

ARIZONA.

The wooded area of this Territory is estimated at 25,000 square miles, or 22 per cent of the total area. The estimate has been obtained, in the main, from maps of this organization, which cover the northern part of the Territory, embracing most of its woodland. The wooded regions about the head of Gila River, which constitute practically all the remaining areas, were outlined by Mr. Gilbert Thompson, of this Survey, from his knowledge of the locality.

UTAH.

The wooded area of Utah is 10,000 square miles, or 12½ per cent of the area of the State, as determined by the Powell Survey.

IDAHO.

The wooded area of Idaho is estimated at 35,000 square miles, or 42 per cent of its area. This is comprised almost entirely in the northern portion of the State. Data for this estimate were obtained from maps prepared by Mr. Leiberg and from the atlas sheets of this Survey.

WASHINGTON.

Of this, one of the most important lumber States of the country, the wooded area is estimated at 47,700 square miles, or 71 per cent of the area of the State. This wooded area extends from the Pacific coast eastward to the eastern base of the Cascade Range, and includes also the northern portion of the State and a narrow, irregular strip upon the east.

OREGON.

The wooded area of Oregon is estimated at 54,300 square miles, or 57 per cent of the area of the State. The outlines of the woodland in this State were, in large part, obtained from the explorations of Mr. Leiberg. From the coast to the eastern base of the Cascades the State is timbered, with the exception of small prairies and clearings in Willamette and other valleys in the depression between the Cascade and Coast ranges. The Blue Mountains, in the northeast, are wooded, and timber is found upon several of the ranges traversing the central and southeastern portions of the State.

NEVADA.

The wooded area of Nevada is estimated at 6,100 square miles. Most of this is in the western portion, where the Sierra forests project over into this State, and a little is found upon the summits of the higher ranges in other parts of the State. The wooded area forms less than 6 per cent of the area of the State.

CALIFORNIA.

Of the area of California 44,700 square miles are woodland. Nearly all this area is comprised in the northern half of the State. The forests cover the Coast Ranges from a little above the Bay of San Francisco to the State line, and cover the Sierra throughout its entire extent, with the exception of small areas above timber line. Some woodland, but not much, is found in the Coast Ranges and in the ranges of southern California. The wooded area comprises 22 per cent of the area of the State.

SUMMARY.

The foregoing figures are summarized in the following table:

Wooded areas in the United States, by States.

State.	Total wooded area.	Percentage of land area.
	Sq. miles.	
Maine	23,700	79
New Hampshire	5,200	58
Vermont	3,900	43
Massachusetts	4,200	52
Rhode Island	400	40
Connecticut	1,900	39
New York	18,700	39
New Jersey	3,234	43
Pennsylvania	23,200	51
Delaware	700	36
Maryland	4,400	44
District of Columbia	12	20
Virginia	23,400	58
West Virginia	18,400	73
North Carolina	35,300	73
South Carolina	20,500	68
Georgia	42,000	71
Florida	37,700	70
Alabama	38,300	74
Mississippi	32,300	70
Louisiana	28,300	62
Texas	64,000	24
Arkansas	45,000	84
Kentucky	22,200	55
Tennessee	27,300	65
Ohio	9,300	23
Indiana	10,800	30
Illinois	10,200	18
Michigan	38,000	67

Wooded areas in the United States, by States—Continued.

State.	Total wooded area.	Percentage of land area.
	Sq. miles.	
Wisconsin	31,750	58
Minnesota	52,200	66
Iowa	7,000	13
Missouri	41,000	60
North Dakota	600	1
South Dakota	2,500	3
Nebraska	2,300	3
Kansas	5,700	7
Indian Territory	20,000	65
Oklahoma	4,400	11
Montana	42,000	29
Wyoming	12,500	13
Colorado	33,500	32
New Mexico	23,700	19
Arizona	25,000	22
Utah	10,000	13
Idaho	35,000	42
Washington	47,700	71
Oregon	54,300	57
Nevada	6,100	6
California	44,700	22
	1,094,496	37

The total is 37 per cent of the area of the country, excluding Alaska.

AMOUNT OF MERCHANTABLE STANDING TIMBER, AND SUMMARY AND SOURCES OF DATA.

Of the amount of standing timber of merchantable size—i. e., of the size commonly used at the mills—very little data have been published. It is true that estimates have been made in the interests of lumber dealers, railroads (of land grants), and States (for making selections), but in very few cases have these "cruisings" been collected and the results digested and published. Most of the estimates of standing timber which have found their way into print are the merest guesses, and are not worth the paper they are printed on.

Cruisings made in the most careful manner by experienced men are often found to differ materially from one another. This may, however, be due to other causes than man's fallibility. The standard of the mill practice differs greatly in different parts of the United States, and has differed widely at different times. For instance, in the Lake States trees are cut and sent to the mill which will square 8, or even only 6 inches, and trees from which only one stick can be obtained are cut; while, on the other hand, in Oregon, Washington, and California the smallest tree which is cut must furnish at least two sticks, each of which must square at least 12 inches. The cruiser's practice, of course, follows the mill practice, and the result is that the cruiser's estimates under Washington practice would show vastly less timber than if made under Michigan practice. An estimate of the standing timber in Washington made twenty-five years hence, when timber will have become scarce and the lumberman's standard lowered, will doubtless show twice as much timber in the same area as if made to-day.

The first attempt to obtain the amount of standing timber in any considerable part of the United States was that of Prof. C. S. Sargent, under the Tenth Census, in 1880. This was a pioneer work, and it gave us the first definite ideas concerning any portion of our resources in standing timber. His estimates were obtained for the most part by well-qualified experts, and are probably, as far as they go, approximations to the truth. They were, however, confined to certain Coniferæ in certain regions, no estimate being made of hard woods, and they were, with the exception of the redwoods of California, limited to portions of the Eastern forests. They were limited to saw timber—i. e., the timber sufficiently large and of suitable quality for the mill.

In 1896 the State fire warden of Minnesota, Gen. C. C. Andrews, published in his second annual report an estimate of the timber of that State, including not only the milling timber, but firewood as well. His method consisted, in the main, in obtaining from township and county officers estimates of the timbered areas and of the average stand. At about the same time Mr. C. A. Smith, a prominent lumberman of Minneapolis, who has had a large part of the timbered regions of the State cruised in his interest, made a similar estimate, confining it, however, to the white and yellow pine of the State suitable for milling purposes. This was based, doubtless, upon the cruisings in his possession, and the result differed widely from all other estimates.

In 1897 an estimate was made of the standing timber of Wisconsin by Mr. Filibert Roth, of the United States Department of Agriculture, in cooperation with the geological survey of Wisconsin. It is not clear from his report, which was published as Bulletin 16 of the Division of Forestry, Department of Agriculture, what method was employed in obtaining his result, but presumably, to a large extent, it is a collection and digestion of actual cruisings.

Several estimates have been made of the redwoods of California, which occupy a narrow strip in the western part of the Coast Ranges north of the Bay of San Francisco. The first of these to be mentioned is that of Prof. C. S. Sargent, made in connection with his work for the Tenth Census, already mentioned; a second was made by the State board of forestry of California; and a third by Mr. A. C. Tibbetts, secretary of the Humboldt Lumber Manufacturers' Association, and published in the Eleventh Census report upon forest industries.

In the report just cited there is a table giving the areas of timbered lands and the stands of timber upon them which were in 1890 owned by manufacturers of lumber. The data are given by States, and include timbered area in acres, the total stand of merchantable timber, and the average stand per acre. These figures are, of course, by no means complete, since they include only a small part of the timbered land. The average stand per acre is necessarily that of picked timber land, and is by no means an average of the timbered land in the State, and therefore, as an aid in discovering the total amount of timber in the country or in any State, they have little value.

The above paragraphs summarize all the sources of information known to me relating to the statistics of standing timber in this country. There are doubtless figures relating to small areas, scattered about in fugitive form, which might be used, but I am persuaded that any such figures would add little to our knowledge.

The following table contains a summary of the information derived from the above sources. It is arranged by States, by species of timber, and by authorities, and is placed in this form in order to bring together different estimates of the same thing, the figures being given in millions of feet B. M.

Estimates of merchantable standing timber.

State.	Species.	Authority.	Millions of feet B. M.
Maine	White pine	Sargent, 1880	475
	Spruce	do	5,000
New Hampshire	do	do	1,510
	Hemlock	do	165
	Hard wood, including firewood.	do	33,750
Vermont	Spruce	do	755
New York: (Adirondack region)	White pine	do	320
	Spruce	do	5,000
	Hemlock	do	3,000
	Hard wood, including firewood.	do	6,400
Pennsylvania	White pine	do	1,800
	Hemlock	do	4,500
West Virginia	White pine	do	990
Michigan	do	do	35,000
Wisconsin	do	do	41,000
	do	Roth, 1897	15,000
	Norway pine	do	2,300
	Hemlock	do	11,700
	Hard wood	do	16,000
Minnesota	White pine	Sargent, 1880	8,170
	do	Andrews, 1896	16,849

Estimates of merchantable standing timber—Continued.

State.	Species.	Authority.	Millions of feet B. M.
Minnesota	Norway pine	Andrews, 1896	3, 417
	Other Coniferæ	.....do	7, 250
	Hard wood, including fire-wood.	.....do	107, 000
	White and Norway pine	Smith, 1896	40, 000
North Carolina	Long-leaved pine	Sargent, 1880	5, 229
South Carolina	.....do	.....do	5, 316
Georgia	.....do	.....do	16, 778
Florida	.....do	.....do	6, 615
Alabama	.....do	.....do	18, 885
	Short-leaved pine	.....do	2, 307
Mississippi	Long-leaved pine	.....do	18, 200
	Short-leaved pine	.....do	6, 775
Louisiana	Long-leaved pine	.....do	26, 588
	Short-leaved pine	.....do	21, 625
Texas	Long-leaved pine	.....do	20, 508
	Short-leaved pine	.....do	26, 093
	Loblolly pine	.....do	20, 907
Arkansas	Short-leaved pine	.....do	41, 315
California	Redwood	.....do	25, 825
	.....do	State board of forestry, 1885.	30, 500
	.....do	Tibbetts, 1890	97, 505

White pine is found in all the New England States and in New York, Pennsylvania, Michigan, Wisconsin, Minnesota, and West Virginia. In southern New England—i. e., Massachusetts, Rhode Island, and Connecticut—the original growth has been practically cut away, leaving only second-growth pine, little of which is of sufficient size for the mill. Of the other States, it will be seen that Professor Sargent makes no estimate of the amount in New Hampshire or Vermont. On the basis of the figures given by Sargent and quoted above, he estimated that in eight years the supply of white pine would be gone. Since then eighteen years have elapsed, and the supply of white pine, as indicated by its price in the market, has not materially diminished. Although in these eighteen years an amount greater than that which Sargent estimated to be standing in 1880 has been cut, the amount still standing is, from all appearances, quite as large as his estimate made in 1880. In 1897 Mr. Fernow, of the Department of Agriculture, hazarded a guess concerning the amount of pine standing at that time, from which he estimated that it would last seven years more.

In Maine an amount fully equal to the estimated amount given by Sargent as standing in 1880 has since been cut, and the annual cut shows no appreciable diminution.

While in 1880 Professor Sargent estimated that there were standing in the three States of Michigan, Wisconsin, and Minnesota only 84,000 million feet of white pine, there were cut from these States in the succeeding sixteen years not less than 121,000 million feet, and the best estimates which we have at present indicate that there still remains at least as much in these States as was reported to be standing in 1880.

A comparison of the estimates of white pine in Minnesota, made, respectively, by Sargent, Andrews, and Smith, shows that after sixteen years' cutting in the State, Andrews found twice as much white pine in 1896 as the estimated amount in 1880, while Mr. Smith's estimate, made at the same time as General Andrews's, is double that of the latter. Owing to the fact that Mr. Smith based his estimate largely upon actual cruisings of the pine land, it is altogether probable that his estimate is much nearer the truth than the others.

Opinions of lumbermen differ widely regarding the probable time of exhaustion of the white-pine supply, but the consensus of opinion seems to be that within twenty-five or thirty years white pine will become so scarce as to be no longer a factor of importance in the lumber industry. At present the cut shows little diminution, but the fact that lumbermen are searching the country for substitutes for white pine is significant.

The total amount of long-leaved pine in the nine Southern States given by Sargent is 118,119 million feet; that of short-leaved pine, 98,115 million feet; that of loblolly pine, 20,907 million feet; a total of the three species of 237,141 million feet.

The estimates of the redwood of California, as will be seen, differ very widely, ranging from 25,825 to 97,505 million feet. This is well known to be the densest forest in North America—indeed, in all probability, considering the amount of merchantable timber contained therein, upon the globe. Single acres have been known to yield a million and a half feet of lumber, and single trees to cut as much as 100,000 feet.

In the report of the State forestry commission of California, above quoted, the area of effective redwood land is given as approximately 1,000,000 acres. If this statement of area be correct it follows that the average amount of redwood timber upon this land, according to Sargent's estimate, is about 25,000 feet per acre, and according to the estimate of the commission, 30,000 feet per acre. Neither of these is a large yield. There are many townships in western Washington and Oregon containing far more than this amount, and yet these forests, although dense, are not regarded as extraordinary in this respect. On the other hand, accepting the redwood area as above given, the estimate furnished by Mr. Tibbetts would give nearly 100,000 feet per acre as an average. This would indicate a very large product, but in all probability it is nearer the truth than the other estimates.

The work of the last season under this organization has resulted in furnishing statistics of standing timber over areas aggregating 181,300 square miles, which may be enumerated as follows: Washington, Oregon, northern Idaho, a portion of the Bitterroot Forest Reserve in Montana, the Teton and a part of the Yellowstone Park forest reserves, the Bighorn Forest Reserve of Wyoming, the Black Hills Forest Reserve of South Dakota, the San Francisco Forest Reserve of Arizona, and the San Jacinto, San Gabriel, and San Bernardino forest reserves of southern California. The amounts in the several areas are as follows, in millions of feet B. M.:

Standing timber in certain regions of western United States.

Locality.	Standing timber.
Washington	114,778
Oregon	234,653
Priest River Reserve	1,904
Northern Idaho, excluding Priest River Reserve	1,696
Bitterroot Reserve, Montana portion	1,022
Bighorn Reserve, Wyoming	210
Teton Reserve, Wyoming	75
Black Hills Reserve, South Dakota	1,502
San Francisco Forest, Arizona	8,100
San Jacinto Reserve, southern California	98
San Gabriel Reserve, southern California	60
San Bernardino Reserve, southern California	479

These will be discussed fully in the following part of this report and in the detailed reports of my assistants.

CONSUMPTION OF TIMBER IN THE UNITED STATES AND IN THE CORDILLERAN REGION.

Statistics of the consumption of timber in the United States have been obtained only by the Census Office, the latest being those of 1890. The principal items of forest products, as returned by that census, are as follows:

Principal forest products of the United States in 1890.

Description.	Amount.	Value.
Sawed lumber ....million feet B. M.	23,500	$267,000,000
Logs ....do	1,445	10,500,000
Telegraph poles ....thousands	117	200,000
Fence posts ....do	4,723	400,000
Ties ....do	5,496	1,600,000
Piles ....do	158	300,000
Shingles ....do	9,275	17,000,000
Staves ....do	1,178,552	7,800,000
Headings ....do	182,700	4,900,000
Laths ....do	2,263,300	3,500,000

The above, with the addition of a few other items, give a total value of $403,700,000. To this is to be added the item of fuel, of nearly equal value. Statistics regarding fuel consumption were collected in 1880 by Prof. C. S. Sargent, in connection with the Tenth Census. His investigation showed that on an average each inhabitant of the country consumed approximately 2.8 cords of fuel per annum. Applying this to the population of 1890 gives a total consumption of about 180,000,000 cords. The average value per cord in 1880 was $2.20, which we may assume has remained unchanged, thus giving a total value to the annual supply of fuel of $396,000,000. This, added to the other items, gives a total of about $800,000,000 as the value of the forest product of the country, an amount slightly in excess of its mineral production.

The total amount of sawed lumber consumed in the country was, as stated in the table above, 23,500 million feet B. M. The timber to supply this demand must fulfill certain conditions of size and quality—conditions which differ greatly under present practices in different parts of the country. On the Pacific coast the standard for saw timber is extremely high. Trees which will not square 12 inches and furnish at least two lengths are not at present considered as furnishing saw lumber, and the waste from the trees which are cut for lumber is enormous. On the other hand, in the eastern lumber regions, and even in the Rocky Mountain country, trees which will square as low as 6 inches, are being cut for lumber.

For poles, ties, rails, and other minor uses lumber is cut, and to a considerable extent the waste of the saw timber is utilized for certain of these purposes.

But the great item of timber consumption is firewood. The above estimate of the annual consumption of firewood, reduced to feet B. M., so as to make it comparable with the sawmill consumption, shows that we burn for heating and manufacturing purposes not less than 180,000 million feet B. M., an amount seven times as great as that used in the sawmill and four times as great as is used for all other purposes. It must be remembered, however, that most of the firewood supply consists of timber which is not and can not be suitable, in species, size, or quality, for the mill. This fact is insured by the relative prices of the two qualities, since wood suitable for milling purposes brings a much higher price than for firewood.

The question is immediately raised whether the supply of wood suitable for fuel, and for fuel only, is in excess of the amount suitable for the mill proportionally to the relative demand for the two. To that the answer may be made in general that it is amply sufficient; that in all regions of the country the supply of wood suitable for fuel only is in excess of its relative demand.

CONSUMPTION OF TIMBER IN THE ROCKY MOUNTAIN AND PACIFIC STATES.

It is of the consumption in the above States that we are especially interested in this report. Lumber, being a very bulky product, is seldom transported far from its region of production. So far as possible the supply is obtained from near-by sources. Especially is this true where the only transportation available is by rail, the rates for which are well-nigh prohibitory to commerce in this commodity.

The following table summarizes the condition of the lumber industry in the Rocky Mountain and Pacific States:

Condition of the lumber industry in the Rocky Mountain and Pacific States.

[In millions of feet. B. M.]

State.	Number of mills.	Lumber.	Fuel.	Total.
Arizona	4	10.8	252	262.8
California	221	519	2,416	2,995
Colorado	109	79	906	985
Idaho	41	18.9	252	270.9
Montana	30	90	396	486
Nevada	....	....	115	115
New Mexico	26	26.3	216	242.3
Oregon	300	493	880	1,373
South Dakota	41	22.8	1,050	1,072.8
Utah	30	14.4	250	264.4
Washington	310	1,156	875	2,031
Wyoming	17	6.3	122	128.3
Total	1,129	2,436.5	7,730	10,226.5

It will be seen from the above table that the lumber cut in the Rocky Mountain States is small—in some of the States absolutely trifling—and that in most of them the consumption of wood is almost entirely confined to that used for fuel; indeed, the consumption of lumber in the sawmills of all the Rocky Mountain States together is little more than half that of California or Oregon, less than a fourth that of Washington, and but one-eighth that of the three Pacific States taken together. The total cut of lumber for sawmills in the West is but one-tenth that of the United States, and is trifling when compared with the supply.

The following table exhibits the growth of the lumber industry in the Rocky Mountain and Pacific States between 1870 and 1890, as shown by the reports of the Ninth, Tenth, and Eleventh censuses:

Lumber industry in Rocky Mountain and Pacific States in 1870, 1880, and 1890.

State or Territory.	Year.	Number of mills.	Capital.	Cost of material.	Value of product.
Arizona	1870	1	$5,000	$1,600	$10,000
	1880	13	102,000	132,000	216,000
	1890	4	213,000	127,000	249,000
California	1870	291	3,856,000	1,986,000	5,227,000
	1880	251	6,455,000	2,243,000	4,229,000
	1890	221	15,834,000	4,356,000	8,454,000
Colorado	1870	32	133,000	117,000	324,000
	1880	96	481,000	700,000	1,051,000
	1890	109	839,000	610,000	1,172,000
Dakota	1870	10	37,000	33,000	72,000
	1880	39	114,000	282,000	436,000
	1890	46	370,000	217,000	452,000
Idaho	1870	10	51,000	20,000	57,000
	1880	48	192,000	231,000	350,000
	1890	41	420,000	187,000	430,000
Montana	1870	31	146,000	172,000	431,000
	1880	36	208,000	278,000	528,000
	1890	30	831,000	547,000	1,178,000
New Mexico	1870	12	47,000	40,000	121,000
	1880	26	75,000	117,000	174,000
	1890	26	193,000	172,000	390,000
Oregon	1870	165	913,000	358,000	1,014,000
	1880	228	1,578,000	1,331,000	2,030,000
	1890	300	7,543,000	2,979,000	5,995,000
Utah	1870	95	338,000	266,000	661,000
	1880	107	273,000	238,000	375,000
	1890	30	197,000	127,000	235,000
Washington	1870	46	1,285,000	580,000	1,307,000
	1880	37	2,456,000	1,188,000	1,735,000
	1890	310	19,445,000	7,930,000	15,068,000
Wyoming	1870	8	110,000	99,000	268,000
	1880	7	27,000	27,000	41,000
	1890	17	160,000	52,000	125,000

FORESTS OF THE WEST.

The forests of the Rocky Mountain region and the Pacific coast are characterized by an almost entire absence of deciduous trees. Indeed, almost all tree growth available for lumber is composed of Coniferæ, consisting of pines, firs, spruces, hemlocks, cedars, and larches.

The distribution of tree growth here, as everywhere else, is a function of rainfall. Where this is less than a certain amount—say 20 inches annually—no species of trees can flourish. The species which can bear the least rainfall are the piñon pine and the juniper. Where the rainfall is greater, other species find it possible to exist. Thus, in going from a region of small rainfall toward a region of great rainfall, one passes through areas occupied by different species, from the piñon and juniper, through quaking aspen, yellow and lodgepole pine, to red fir, spruce, and cedar. Since throughout the Rocky Mountain region the rainfall is least in the valleys, and generally at low levels, the forests are, except near the Pacific coast, confined almost entirely to the higher plateaus and the mountains.

Thus, a rainfall map is in a general way a forest map; and in the Rocky Mountain region, since rainfall is more abundant at the higher elevations, a relief map is, in like manner, a forest map.

Much is known regarding the general distribution of the forests of the West, and of the species of timber, largely because the forests accompany the rainfall closely, and therefore have a direct relation to the relief of the country; and, moreover, because of the numerous explorations and surveys which have been carried on in the West under the auspices of the General Government.

The following general description may help the reader to understand the forest conditions of this region:

In South Dakota the forests are confined to the Black Hills, where they consist almost entirely of yellow pine. They are mainly open forests, of no great density, and with little undergrowth. In certain parts, and especially toward the south, the timber scatters out greatly, leaving large open parks.

In Montana the forests are confined almost entirely to the western half of the State, and therein mainly to the mountains. They increase in density westward and northward, becoming densest upon the Bitterroot Range, the Front Range of the Rocky Mountains, and the numerous ranges lying between them. The timber in this region consists of red fir, yellow pine, white pine, and tamarack. Southward from this region the character of the forest changes, being composed largely, if not mainly, of lodgepole pine.

In Wyoming the densest forests are found in the western corner, including Yellowstone Park and the country east and south thereof. The principal forest tree over this region is lodgepole pine, of small size and of little economic importance. It is densest within the Yellowstone Park and becomes sparse eastward and southward. The Bighorn Mountains are sparsely timbered, bodies of timber alternating with open parks, so that not more than half of the plateau-like summit of the range is wooded.

The only other wooded areas in the State are near the southern border, where the great Colorado ranges project north of the State line, and upon these the timber is small and scanty.

In Colorado timber is confined almost entirely to the high mountains and the high plateaus at their western base, the mountain valleys and parks being without forests. The timber is nowhere large or dense. It consists, in the main, of red fir, yellow pine, Engelmann spruce, and lodgepole pine.

In New Mexico the high mountain ranges and plateaus are timbered, but nowhere densely. The principal forests are upon the southern end of the San Juan Range, where it projects into this Territory, upon the Sangre de Cristo Range, and in the region of high plateaus west of the Rio Grande, in Socorro County. The timber consists of Engelmann spruce, red fir, and yellow pine.

In Arizona the principal body of timber is the San Francisco Forest, which is described somewhat fully further on in this report. It is an open forest of good-sized yellow pine, with little or no underbrush. A similar forest is found upon the high plateau on both sides of the Grand Canyon of the Colorado. The ranges south of the Colorado Plateau, about the heads of the Gila, contain some timber, but none of importance.

In Utah the only timber of consequence is found in the Uinta Range, in the northeast corner of the State. Upon the Wasatch Range the timber is small and scattering.

In Nevada there is but a trifling amount of timber. The timber belt of the Sierra Nevada extends over a small area in the western part, while elsewhere the only arborescent growth is near the summits of the narrow desert ranges.

The northern part of Idaho is heavily timbered, as is fully described in a paper in this report by Mr. Leiberg. This heavy body of timber extends down through the Bitterroot Reserve and gradually thins out south of Salmon River. There is a little timber in the southeastern part, but this is not of importance except for local purposes.

The portion of Washington west of the summit of the Cascade Range was formerly entirely covered with dense forests of great trees—firs, spruce, cedar, and hemlock—although a large proportion of it, nearly half, has been destroyed either by cutting or by burning. The eastern slope of the Cascades is less heavily timbered, but is not an unimportant source of forest products. East of the Cascade Range and north of the Columbia is a region whose forests are only second in density to those of western Washington. The timber in this region consists mainly of white and yellow pine, with some red fir.

In Oregon we find much the same sort of distribution as in Washington. West of the summit of the Cascade Range the forests are dense and very productive, consisting of the same species as in Washington, with the addition in the southern part of a little sugar pine and yellow pine. The eastern slope of the Cascade Range is much less heavily forested, although the timber, which here consists of yellow pine almost exclusively, extends far out on the plateau. In the northeastern portion of the State are the Blue Mountains, whose forests consist largely of yellow pine, covering enormous areas with a rather light growth.

In California the Coast Ranges, from the Oregon boundary nearly down to the Bay of San Francisco, are well forested, mainly with redwood, red fir, and yellow and sugar pine. Into the northern part of this area spruce and hemlock extend southward from Oregon. Upon the west slope of the Sierra are found, mainly between altitudes of 4,000 to 8,000 feet, enormous quantities of sugar pine, which here grows to great size, yellow pine, and red fir, with occasional groves of *Sequoia gigantea*. In the San Gabriel, San Bernardino, and San Jacinto mountains are small areas forested with yellow pine, among which are interspersed a few sugar pines.

MAP SHOWING THE WOODLANDS AND FORESTS OF THE WEST.

A map (Pl. II) showing the extent and distribution of woodland in the Cordilleran region has been compiled from a variety of sources, as follows:

Manuscript atlas sheets of the United States Geological Survey. Wherever the topographic surveys of this organization have been carried on the woodland has been mapped with as great accuracy as possible. These surveys have been extended over an area of 250,000 square miles in various parts of the West.

The maps of the Powell Survey, covering the whole of Utah and northern Arizona.

The Hayden Survey. By this organization were mapped the mountain region of Colorado, the adjacent portions of Utah and New Mexico, and a large detached area in western Wyoming, southeastern Idaho, and northeastern Utah, a total area of about 100,000 square miles.

The Wheeler Survey, which has mapped large areas, mainly in the Southwest.

Cruisings and maps prepared by railroad, wagon road, and lumber companies in Oregon and Washington, including the work done by the Northern Transcontinental Survey along the Northern Pacific Railroad.

Reports of the State Forestry Board of California.

The work of the Biological Survey of the Department of Agriculture.

The reports and maps made by the forestry agents of this office during the last season.

Notes and sketches by J B. Leiberg, W. T. Griswold, myself, and others concerning areas heretofore unpublished.

The colors upon the map indicate the areas occupied by arborescent vegetation, but do not include areas covered with brush.

An attempt has been made to separate those areas which are covered with timber suitable for mill purposes, and which may therefore be known as merchantable timber, from such as bear timber suitable only for firewood, rails, and such inferior uses. That such a distinction is imperfectly made goes without saying, but it is believed that the result is approximately correct.

FOREST CONDITIONS AND STANDING TIMBER OF WASHINGTON.

With the exception of the redwoods of California, the forests of Washington are the densest, heaviest, and most continuous in the United States. Except for a few prairie openings, and except where removed by fire or the ax, they cover the country as a thick mantle from high up on the Cascade Range westward to the shores of the Pacific. In all this region only the Olympics rear a few summits above the forests. Not only are the forests dense overhead, but the undergrowth is dense and tangled beneath. The trees are large, reaching 12 to 15 feet in diameter and 250 feet in height, with clear trunks for 100 or more feet. The timber is mainly red or yellow fir (*Pseudotsuga taxifolia*), mingled with spruce, hemlock, and cedar.

The amount of standing timber in this region has long been a matter of interest, and many wild guesses have been hazarded. As usual in such cases, most of them have been far above the truth. With no data on which to base an estimate the tendency is to exaggerate.

Finding the material ready at hand for obtaining a fairly reliable estimate, requiring only the work of bringing it together and digesting it, I have undertaken this work.

Statistics derived from cruisings recently made have been obtained from all parts of the State, and especially from the heavily timbered portion lying west of the Cascade Range. The sources of this information are as follows:

The Northern Pacific Railroad Company, which has made most elaborate cruisings of that part of its land grant situated west of the Cascade Range, has with great liberality furnished an abstract of all the information in its possession regarding timber lands, including not only the statistics of standing timber but maps showing the areas at present forested, those naturally unforested, those which have been cut over, and those which have been burned. These statistics have been compiled and the maps prepared by Messrs. John M. Rankine and George H. Plummer, of the Northern Pacific Railroad office. The commissioner of the State land office has furnished abstracts of all cruisings made for the selection of lands for the State. Besides the above, several lumber companies and owners of timber land have placed their information at the disposal of this office.

Altogether I have collected the cruisings of 1,679,402 acres. Most of these are in the portion of the State west of the crest of the Cascades, although the eastern slope of the mountains is represented to some extent, and there is a large area cruised in Stevens County, in the northeastern part of the State.

From these data, together with the examinations of the Washington

Reserve, I have estimated the total amount of standing timber in the State to be in the neighborhood of 114,778 million feet B. M. Of this amount more than six-sevenths, or 104,500 million feet, are west of the crest of the Cascades, the remainder, 10,000 million feet, being upon its eastern slope and in the northern and eastern portion of the State. This total is much less than that estimated for Oregon, a fact which I explain by the following considerations: (1) The wooded area is not so great, that of Oregon being 54,300 square miles, that of Washington 47,700 square miles; (2) a considerable part of Washington, in the Cascade Range and the Olympic Mountains, is at a great altitude, upon which the timber is very scattering; (3) much of the eastern slope of the Cascade Range, especially in Okanogan County, is covered with a very sparse growth of timber, although it appears as timber land; (4) the lumber industry in Washington has been, especially in recent years, much more important than in Oregon, and consequently a much larger area has been cut and burned.

The distribution of the lumber trees of Washington is simple: West of the Cascade Range the country, with the exception of the high mountains, is occupied in the main by four species—red fir (*Pseudotsuga taxifolia*), cedar (*Thuja plicata*), hemlock (*Tsuga mertensiana*), and spruce (*Picea sitchensis*). The forests west of the higher part of the Cascades are composed of 64 per cent of fir, 16 per cent of cedar, 14 per cent of hemlock, and 6 per cent of spruce. Toward the coast the proportions of cedar and spruce increase.

Upon the mountains the fir disappears, and hemlock and cedar, especially the former, increase greatly in proportion. In this region the fir is by far the most valuable tree, and, while other species occurring with the fir are used, areas which do not contain fir are regarded at present as of no value. High up in the mountains only subalpine species occur. East of the mountains the timber consists almost entirely of lodgepole and yellow pine, with some white pine in Stevens County, in the northeastern part of the State. A little fir also is found at the eastern base of the range, scattered through the pine forests.

The following table gives the estimated amount of merchantable timber in each county, in thousands of feet B. M., as at present estimated by lumbermen. If it were cut under the practice which prevails at present, these figures represent a close approximation to the amount which would be realized. There is no question, however, but that, as in the case of the eastern white pine, a much larger amount will ultimately be realized, for several reasons:

First, the standard will certainly be lowered, so that instead of utilizing only one-third of the tree two-thirds may be used, and many small trees now destroyed by fire in the culled areas will be cut; second, species not now used may come into the market; third, areas now considered inaccessible will serve as sources of supply; fourth, the new growth on cut and burned areas will reach merchantable size long before the old growth is exhausted.

In illustration of the difference between the supply as viewed by the Washington lumbermen and the actual amount, take the figures given by Mr. Ayres in his report on the western part of the Washington Reserve. Under Washington practice he found but 400 million feet in that area, consisting of red fir. But under the Minnesota practice, and estimating the contents of all species without regard to accessibility, he found not less than 14,400 million feet. This is, of course, an extreme case, but it is probably paralleled throughout the Cascade Range and in the Olympics.

Merchantable timber in the State of Washington, by counties.

Counties. a	Merchantable timber.	Counties.	Merchantable timber.
	Million feet B. M.		*Million feet B. M.*
Asotin	81	Lincoln	14
Chehalis	18,579	Mason	2,091
Clallam	9,072	Okanogan	2,665
Clarke	2,342	Pacific	7,813
Columbia	243	Pierce	6,520
Cowlitz	5,216	Skagit	10,362
Douglas	31	Skamania	4,661
Ferry	1667	Snohomish	7,709
Garfield	170	Spokane	766
Island	430	Stevens	2,702
Jefferson	4,230	Thurston	2,787
King	7,644	Wahkiakum	2,974
Kitsap	1,141	Wallawalla	5
Kittitas	1,260	Whatcom	1,346
Klickitat	743	Whitman	35
Lewis	8,586	Yakima	893

a The counties omitted contain no merchantable timber.

The counties lying between the crest of the Cascade Range and the Pacific coast have been examined with greater thoroughness than those in the eastern part of the State, and can be described more fully. The cruisings, however, which have been obtained relate only to the portions of the counties occupied by fir timber, other portions being regarded by the cruisers, as stated above, as having no present value for lumber purposes; hence the following facts and figures relate only to the portion of the State lying west of the crest of the Cascade Range, and ignore all the timber in the higher portions of the Cascade Range and the Olympic Mountains; to that extent the presentations concerning the counties of Clallam, Jefferson, Chehalis, Whatcom, Skagit, Snohomish, King, Pierce, Lewis, Cowlitz, and Skamania are incomplete in this regard. As viewed by the lumbermen's practice in western Washington at the present time, the tables accompanying the following county descriptions give the amount of timber of each of the four species represented, with the total stumpage of the county, the areas of merchantable timber, those cut and burned, and those naturally devoid of timber.

CHEHALIS COUNTY.

This county borders upon the Pacific coast, and on the north extends far up into the Olympic Mountains. The northern portion of the county is so high and rugged as to contain little or no merchantable timber, and in other portions of the county are numerous small prairie tracts. Aside from these areas the county was originally heavily forested, mainly with fir in the interior and with spruce and cedar upon the coast. There have been few fires in this county, and the burned area is trifling. Lumbering has, however, been carried on extensively upon the streams flowing into Grays Harbor, and especially upon Chehalis River, nearly one-tenth of the timbered area of the county having been denuded of its forests.

Area of timbered and other lands in Chehalis County, Washington.

	Sq. miles.
Total area	2,104
Merchantable timber area	1,360
Logged area	130
Naturally bare area	47
Burned area	36

Estimate of timber in Chehalis County, Washington.

	M feet B. M.
Fir	9,799,418
Spruce	3,068,307
Cedar	3,474,350
Hemlock	2,236,983
Total	18,579,058
Average per acre of timbered land, in feet B. M.	21,300

CLALLAM COUNTY.

This county occupies the northern part of the Olympic Peninsula. The southern portion of the county comprises a part of the Olympic Mountains, and is not regarded as containing any timber of present merchantable value. The remainder of the county was heavily forested, but the ax has made inroads in these forests along the shores of Puget Sound as far west as Crescent Bay, and fires have extended inland from these cuttings to the mountains, destroying considerable areas of timber. The western part of the county is still an unbroken forest.

The forests of this county are remarkable in the fact that they contain a large proportion of hemlock, the amount of this tree being larger than that of the red fir.

Area of timbered and other lands in Clallam County, Washington.

	Sq. miles.
Total area	1,824
Merchantable timber area	900
Logged area	117
Burned area	151

Estimate of timber in Clallam County, Washington.

	M feet B.M.
Fir	3,045,297
Spruce	1,758,845
Cedar	547,617
Hemlock	3,719,840
Total	9,071,599
Average per acre of timbered land, in feet B.M.	15,700

CLARKE COUNTY.

This county lies in the southwestern part of the State, bordering on the south and west upon Columbia River. Originally it was entirely covered with heavy forests with the exception of a few small prairie tracts.

But little timber has been cut in the county, lumbering being principally confined to the line of the Portland, Vancouver and Northern Railroad, and, on the other hand, the timber upon two-thirds of the county has been destroyed by fire, the burned areas lying principally in the south and west parts of the county, leaving large bodies of forest in the eastern part.

The forest consists almost exclusively of fir, there being very little cedar and hemlock and no spruce whatever.

Area of timbered and other lands in Clarke County, Washington.

	Sq. miles.
Total area	648
Merchantable timber area	192
Logged area	25
Naturally bare area	10
Burned area	421

Estimate of timber in Clarke County, Washington.

	M feet B. M.
Fir	2,124,126
Cedar	132,700
Hemlock	84,860
Total	2,341,686
Average per acre of timbered land, in feet B.M.	19,000

COWLITZ COUNTY.

This county lies in the southern part of the area, being limited on the south by Lewis and Columbia rivers. The eastern portion of the county comprises the westward slopes of Mount St. Helens, and includes a considerable area the timber on which is not regarded as merchantable. Aside from this and a few areas of prairie the county was originally covered with fine, merchantable forests. Fires have, however, been extremely disastrous in this county, destroying the timber on large areas, particularly in the eastern and southern parts of the county.

Lumbering has been carried on along the Columbia and Cowlitz rivers, and considerable areas have thus been denuded; but this bears little comparison to the areas denuded by fire, which comprise fully one-half of the portion originally covered by merchantable forests.

Area of timbered and other lands in Cowlitz County, Washington.

	Sq. miles.
Total area	1,124
Merchantable timber area	400
Logged area	80
Naturally bare area	68
Burned area	500

Estimate of timber in Cowlitz County, Washington.

	M feet B. M.
Fir	3,932,591
Spruce	1,089
Cedar	627,571
Hemlock	655,184
Total	5,216,435
Average per acre of timbered land, in feet B. M	20,400

ISLAND COUNTY.

This comprises a group of islands in the northern part of Puget Sound, including Whidby and Camano islands. These islands originally were entirely covered with fir forests, but have been almost completely denuded by the ax.

Area of timbered and other lands in Island County, Washington.

	Sq. miles.
Total area, all logged	220

Estimate of timber in Island County, Washington.

	M feet B. M.
Fir	250,000
Cedar	180,000
Total	430,000

The above timber is reported as still standing upon culled land.

JEFFERSON COUNTY.

This county lies upon the Olympic Peninsula, stretching from Hood Canal, upon the east, to the Pacific coast. The central portion of the county, comprising three-fourths of it, lies within the Olympic Mountains, and contains no timber of present value for milling purposes. Elsewhere the county was formerly heavily forested, on the east with fir, on the west mainly with cedar and spruce. The timber of the eastern portion has been in the main destroyed either by the ax or by fire, mainly by the latter. The timber in the western portion of the county is as yet untouched either by fire or by the ax.

The forests of this county are remarkable because of the large proportion of cedar therein, more than half the forest being of this species, while of fir, elsewhere the most abundant species, there is comparatively little.

Area of timbered and other lands in Jefferson County, Washington.

	Sq. miles.
Total area	1,688
Merchantable timber area	430
Logged area	96
Naturally bare area	100
Burned area	115

Estimate of timber in Jefferson County, Washington.

	M feet B. M.
Fir	794,232
Spruce	267,427
Cedar	2,124,725
Hemlock	1,043,776
Total	4,230,160
Average per acre of timbered land, in feet B. M.	15,300

KING COUNTY.

This county is in the middle of the State north and south, and extends from the crest of the Cascade Range westward to the shores of Puget Sound. Much of the eastern part of the county lies high up in the Cascade Range, and contains little timber of present merchantable value. Aside from this and a few trifling areas of prairie, the county was originally heavily forested, but the forests have been largely removed by fire or the ax. The latter has taken the timber from Vashon and Maury islands, from the shores of Puget Sound, and of lakes Washington and Sammamish, and from a broad belt along the line of the Northern Pacific Railroad, together with other smaller areas in the interior of the county. Fires have done a vast amount of damage in various parts of the county, mainly in its central portion, although the mountainous regions have not been neglected by it. Indeed, fully one-half of the area formerly covered with merchantable timber has been devastated by fire.

Area of timbered and other lands in King County, Washington.

	Sq. miles.
Total area	1,944
Merchantable timber area	580
Logged area	350
Naturally bare area	10
Burned area	520

Estimate of timber in King County, Washington.

	M feet B. M.
Fir	5,251,784
Spruce	49,248
Cedar	1,252,318
Hemlock	1,090,496
Total	7,643 846
Average per acre of timbered land, in feet B. M	20,500

KITSAP COUNTY.

This occupies the northern part of the peninsula separating Hood Canal from Puget Sound. It was originally entirely covered with heavy fir forests. These have been removed almost entirely by the ax from the shores and the islands bordering them. Only a trifling area in the southern portion of the county has been burned, while nearly half the area has been logged. The standing timber consists entirely of fir.

Area of timbered and other lands in Kitsap County, Washington.

	Sq. miles.
Total area	392
Merchantable timber area	200
Logged area	170
Burned area	22

Estimate of timber in Kitsap County, Washington.

	M feet B. M.
Fir	1,140,900
Average per acre of timbered land, in feet B. M	9,000

LEWIS COUNTY.

This is situated in the southwestern part of the State, and extends from the crest of the Cascade Range on the east to the Coast Ranges on the west, including the valley of Cowlitz River. A considerable portion of its area, therefore, is included within the Cascade Range, where the timber is not regarded as of present merchantable value. There are many prairies scattered over its surface, which further reduce the original area of merchantable timber.

The timber upon more than one-third of the area of this county has been burned, the burned areas lying mainly in the eastern half of the county, though they are not by any means confined to this part. The cutting of timber has been carried on mainly in the neighborhood of the Northern Pacific Railroad, which traverses the county from north to south.

Area of timbered and other lands in Lewis County, Washington.

	Sq. miles.
Total area	2,308
Merchantable timber area	815
Logged area	71
Naturally bare area	60
Burned area	820

Estimate of timber in Lewis County, Washington.

	M feet B. M.
Fir	7,236,170
Spruce	1,311
Cedar	883,627
Hemlock	465,154
Total	8,586,262
Average per acre of timbered land, in feet B. M	16,500

MASON COUNTY.

This county includes the southeastern part of the Olympic Mountains and much of the country bordering Hood Canal. The portion within the Olympic Mountains is not regarded as containing timber of merchantable value. Elsewhere, however, with the exception of a few small prairie tracts, it was originally heavily timbered. Fires have done little damage, but timber cutting has been extensive. The forests have been removed from the shores of Hood Canal and other inlets from Puget Sound, as well as from much of the interior of the county; indeed, it appears that nearly two-fifths of the area has been logged.

The forest consists almost entirely of fir, the amounts of other species being trifling.

Area of timbered and other lands in Mason County, Washington.

	Sq. miles.
Total area	996
Merchantable timber area	575
Logged area	220
Naturally bare area	6
Burned area	12

Estimate of timber in Mason County, Washington.

	M feet B. M.
Fir	2,055,648
Spruce	492
Cedar	25,970
Hemlock	8,955
Total	2,091,065
Average per acre of timbered land, in feet B. M	5,600

PACIFIC COUNTY.

This is the southwesternmost county of the State, bordering upon the Pacific and Columbia River. Its surface in the interior is somewhat broken by the Coast Ranges, although the relief is nowhere great. It is drained by Willapa and Nasel rivers.

Originally the entire surface, with the exception of a few sandy tracts near the coast, was covered with fine forests, composed almost entirely of fir in the interior, and of cedar and spruce near the coast.

Logging has been carried on along the two rivers above mentioned, and to some extent immediately on the coast. Altogether only an area of 42 square miles has been logged.

Fires have not been especially prevalent or destructive in this county, having destroyed the timber upon an area of only 59 square miles.

Area of timbered and other lands in Pacific County, Washington.

	Sq. miles.
Total area	896
Merchantable timber area	747
Logged area	42
Naturally bare area	12
Burned area	59

Estimate of timber in Pacific County, Washington.

	M feet B. M.
Fir	5, 498, 224
Spruce	814, 953
Cedar	713, 238
Hemlock	786, 652
Total	7, 813, 067
Average per acre of timbered land, in feet B. M	16, 300

PIERCE COUNTY.

This, one of the central counties of the region, extends from the crest of the Cascade Range westward to Puget Sound, and includes several islands in the sound. In the east it includes Mount Rainier, with an altitude exceeding 14,500 feet, from whose summit radiate great areas of snow and ice. A large area in the eastern part of this county contains no timber of merchantable value at present. A considerable area has been logged, including nearly all of the islands, large tracts around the city of Tacoma, and others along White and Puyallup rivers.

This county has been singularly free from fires, only a trifling area having as yet been burned. There are, however, large tracts, covering many scores of square miles south of the city of Tacoma, which are naturally timberless.

Area of timbered and other lands in Pierce County, Washington.

	Sq. miles.
Total area	1, 376
Merchantable timber area	563
Logged area	200
Naturally bare area	148
Burned area	62

Estimate of timber in Pierce County, Washington.

	M feet B. M.
Fir	4,778,091
Spruce	56,075
Cedar	618,012
Hemlock	1,067,953
Total	6,520,131
Average per acre of timbered land, in feet B. M	18,000

SAN JUAN COUNTY.

This, one of the northwestern counties of the State, is composed entirely of islands in Puget Sound, the principal of which are San Juan, Orcas, Lopez, Blakely, Shaw, and Waldron.

All these islands were originally covered with a heavy forest, composed of red fir almost exclusively, but, being easily accessible, the entire area, 600 square miles, has been logged.

SKAGIT COUNTY.

This is in the northwestern portion of the State, and extends from the crest of the Cascade Range to Puget Sound, including a number of islands in the sound. The eastern portion, including much more than half the county, being mountainous, is not regarded as containing merchantable timber. The western portion, comprising perhaps one-third of the county, was formerly entirely forested, with the exception of a considerable tract of prairie about the mouth of Skagit River.

There have been no fires of magnitude within the county, but logging has been extensively carried on. The islands have been cleared entirely and the lands in the neighborhood of the coast and the immediate valley of Skagit River have been cleared as far up as the mouth of the Sauk.

Area of timbered and other lands in Skagit County, Washington.

	Sq. miles.
Total area	1,960
Merchantable timber area	575
Logged area	196
Naturally bare area	90
Burned area	12

Estimate of timber in Skagit County, Washington.

	M feet B. M.
Fir	5,841,229
Spruce	184,096
Cedar	2,517,693
Hemlock	1,819,404
Total	10,362,422
Average per acre of timbered land, in feet B. M	28,000

SKAMANIA COUNTY.

This county is in the southern portion of the State, bordering on Columbia River, and extending thence northward well into the Cascade Range. In the northwestern portion of the county is the extinct volcano of St. Helens, while well into the northeast extend the western spurs of Mount Adams. The northern portion of the county is therefore extremely rugged, mountainous, and elevated, and the spurs from these mountains extend southward nearly to Columbia River.

The northern half of the county is not regarded by lumbermen as containing any accessible merchantable timber, although with exception of the summits of the highest mountains, which are above timber line, it was formerly wooded. The southern half was at one time timbered quite heavily, especially toward the west. In recent years, however, fires have destroyed the timber in more than half the area of the county. These fires have invaded the eastern and western portions, leaving between them a narrow belt of forests, together with a broad strip along Columbia River; indeed, the timber upon more than half the area of the county has been thus destroyed.

But little of the timber of this county has been cut. Logging operations extend along Columbia River across the county, reaching perhaps a mile back from the river and up a few of the streams flowing into it.

The forests of this county consist mainly of fir and almost entirely of this species and hemlock. The amount of cedar is trifling and there is no spruce in the county.

Area of timbered and other lands in Skamania County, Washington.

	Sq. miles.
Total area	1,636
Merchantable timber area	430
Logged area	57
Timberless area	58
Burned area	926

Estimate of timber in Skamania County, Washington.

	M feet B. M.
Fir	3,675,960
Cedar	21,411
Hemlock	963,759
Total	4,661,130
Average per acre of timbered land, in feet B. M.	17,000

SNOHOMISH COUNTY.

This county extends from the crest of the Cascade Range to Puget Sound. The eastern part is composed of high and rugged mountains, and contains little, if any, merchantable timber. The western half was originally forested, with the exception of a few tracts of prairie.

Logging has, however, been carried on extensively in this county, two-fifths of the area formerly timbered having been stripped by the ax. Burns have not been extensive or destructive.

The forest consists of fir and cedar, the amount of hemlock being trifling, with no spruce whatever.

Area of timbered and other lands in Snohomish County, Washington.

	Sq. miles.
Total area	1,720
Merchantable timber area	634
Logged area	280
Naturally bare area	24
Burned area	40

Estimate of timber in Snohomish County, Washington.

	M feet B. M.
Fir	5,244,741
Cedar	2,379,888
Hemlock	84,141
Total	7,708,770
Average per acre, in feet B. M	19,000

THURSTON COUNTY.

This county lies in the central part of the area here under description, bordering on the north upon Puget Sound. Its area was, with the exception of numerous prairie tracts, originally covered entirely with fine forests, mainly of fir. At present all the forests in the neighborhood of Puget Sound have been cut away. Fires have not been prevalent and but little timber has been destroyed by this means.

Area of timbered and other lands in Thurston County, Washington.

	Sq. miles.
Total area	768
Merchantable timber area	380
Logged area	147
Naturally bare area	100
Burned area	56

Estimate of timber in Thurston County, Washington.

	M feet B. M.
Fir	2,608,125
Spruce	462
Cedar	108,949
Hemlock	69,807
Total	2,787,343
Average per acre of timbered land, in feet B. M	11,450

WAHKIAKUM COUNTY.

This county lies in the southwestern part of the State, bordering on Columbia River. With the exception of certain islands in the Columbia and small tracts about the mouths of certain tributary streams, the entire area was heavily forested. Lumbering has been carried on along the shores of the Columbia and on Grays and Deep rivers. Fires also have been somewhat prevalent in the county, but more than two-thirds of the area of the county is still covered by fine forests.

Area of timbered and other lands in Wahkiakum County, Washington.

	Sq. miles.
Total area	244
Merchantable timber area	172
Logged area	40
Burned area	32

Estimate of timber in Wahkiakum County, Washington.

	M feet B. M.
Fir	1,947,150
Spruce	182,520
Cedar	301,757
Hemlock	542,680
Total	2,974,107
Average per acre of timbered land, in feet B. M	27,000

WHATCOM COUNTY.

This is the most northern county of the State west of the Cascade Range. It extends from the summit of the range west to the shores of Puget Sound. In the eastern half of the county are found Mounts Baker and Shuiksan, two great extinct volcanoes, rising high above timber line. This eastern mountainous half of the county is not regarded as containing any timber of present merchantable value. The western half was originally very heavily timbered. Its forests were probably as dense as in any other county in the State, but they have been almost entirely destroyed by fire. Certain areas along the coast, on Nooksook River and on the Bellingham Bay and British Columbia Railroad, have been logged, but the amount of timber thus utilized is small as compared with that destroyed by fire. To illustrate the extent of this devastation, it may be stated that out of a timbered area of 780 square miles not less than 530 square miles have been burned; 164 square miles have been logged, and only 86 square miles of timber of present merchantable value are to be found in the county.

The forest consists almost entirely of fir and cedar, the amounts of hemlock and spruce being trifling.

Area of timbered and other lands in Whatcom County, Washington.

	Sq. miles.
Total area	2,468
Merchantable timber area	86
Logged area	164
Naturally bare area	100
Burned area	530

Estimate of timber in Whatcom County, Washington.

	M feet B. M.
Fir	985, 175
Spruce	18, 580
Cedar	282, 450
Hemlock	60, 190
Total	1, 346, 395
Average per acre of timbered land, in feet B. M.	24, 000

RÉSUMÉ.

The totals from the figures given above are as follows: The entire area of the nineteen counties above described is 24,906 square miles. Of this area but little more than one-third, or 9,039 square miles, is regarded as containing merchantable timber. Besides this an area of 3,205 square miles has already been logged; a much greater area, 3,614 square miles of merchantable timber, has been burned, besides an area of 700 square miles in the mountains not containing merchantable timber. In other words, out of an area of 15,858 square miles formerly covered with merchantable timber, 20 per cent, or one-fifth, has been destroyed by fire; 22½ per cent has been cut; and the remainder, 57½ per cent, is still covered with standing timber. In this entire area there are only 833 square miles which are naturally timberless.

Upon the timbered area there is estimated to be standing 103,503,576 thousand feet B. M., which in itself is sufficient to supply the sawmills of the United States for four years, under the present rate of cutting.

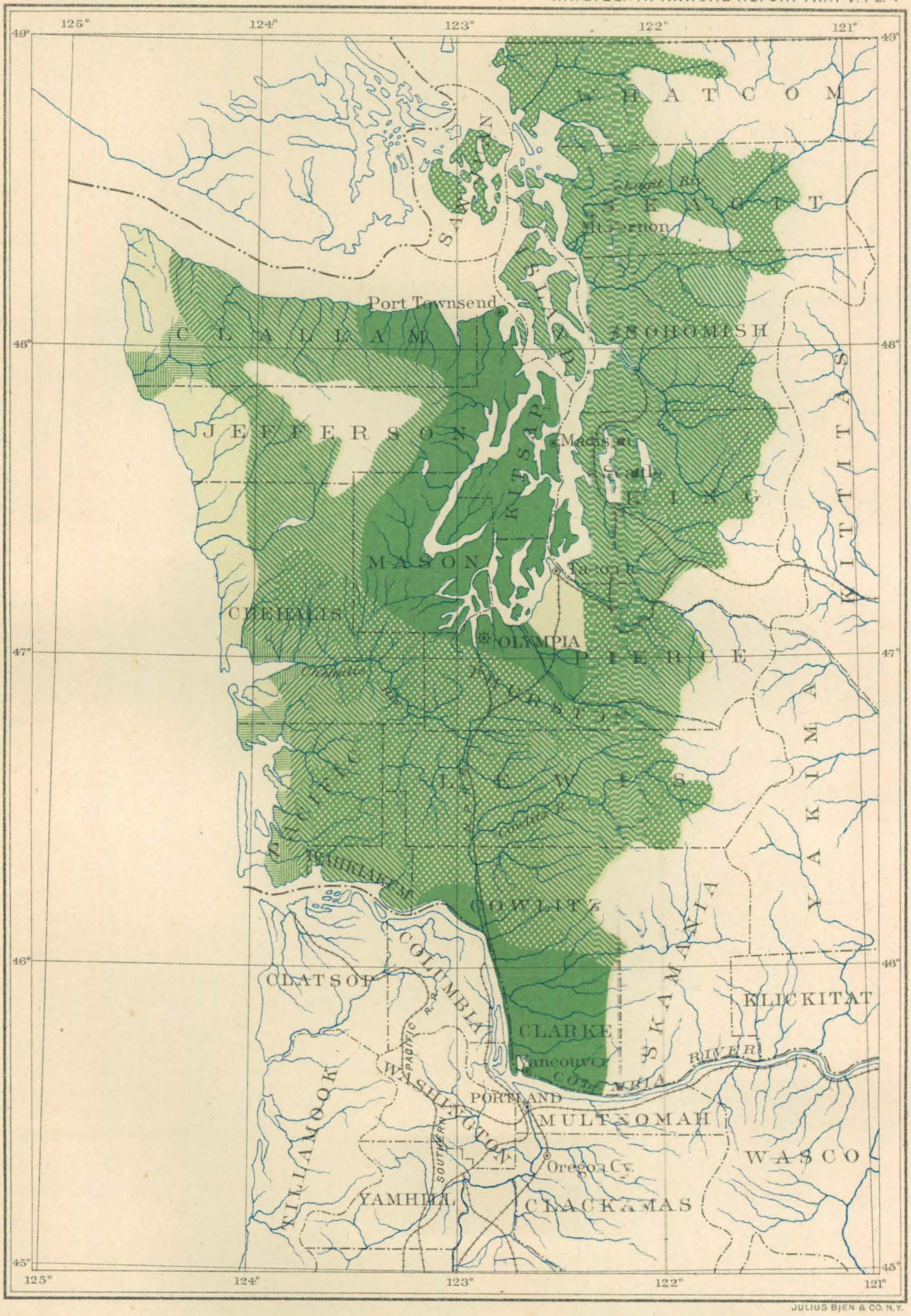
The amounts of each of the four species composing this total are as follows:

Summary of timber in western Washington.

Species.	M feet B. M.	Per cent of total.
Fir	66, 208, 861	64
Cedar	16, 192, 276	16
Hemlock	14, 699, 759	14
Spruce	6, 402, 605	6

If we assume that the logged area contained on an average the same amount of timber per acre as is still standing in other areas, it appears that since lumbering began in this region there have been cut from it 36,000,000 thousand feet B. M.

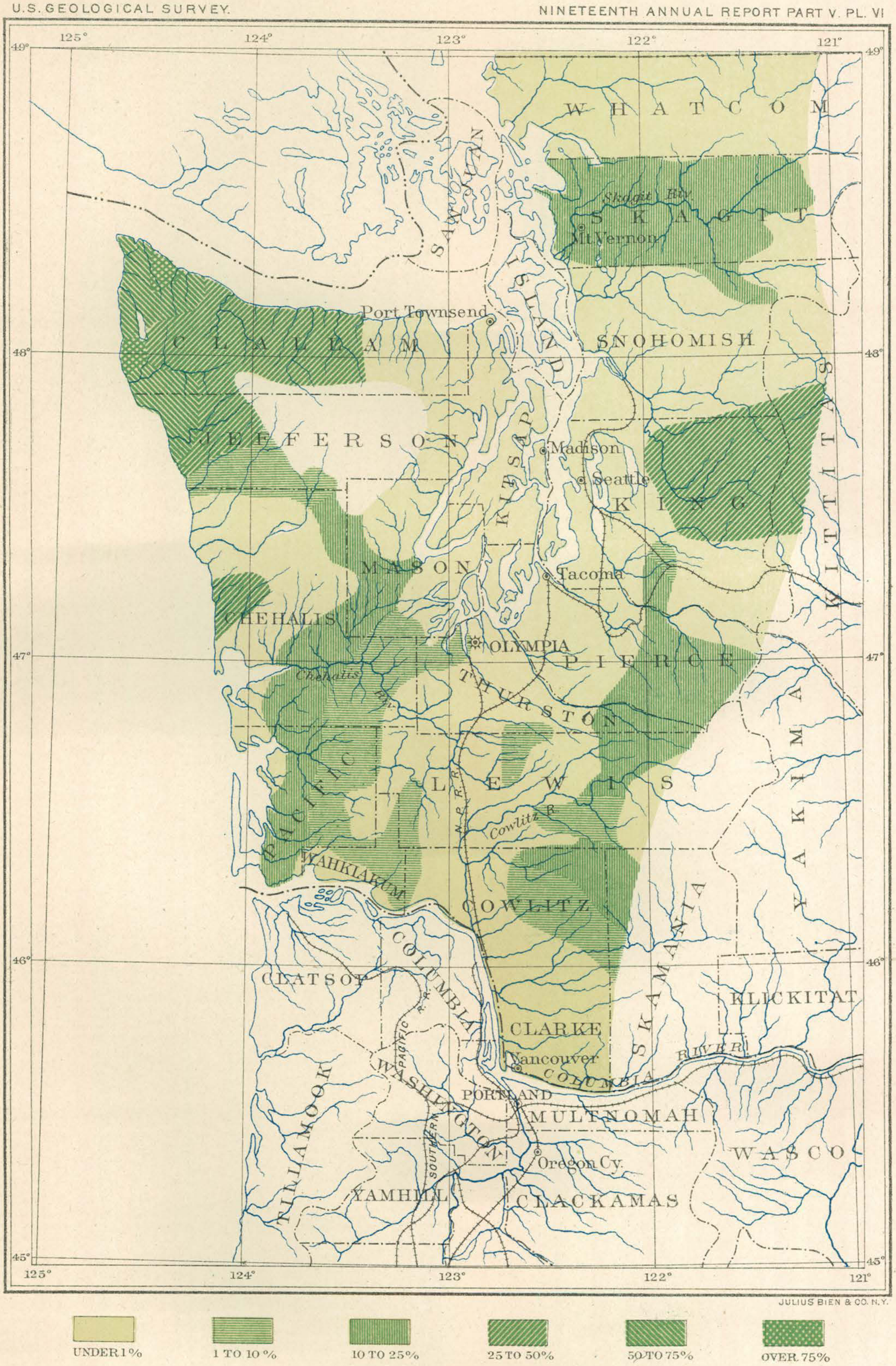
If we make the same assumption regarding the burned area, it appears that there have been destroyed by fire, without the least benefit to the world, the enormous amount of 40,000,000 thousand feet B. M. of lumber. Anyone who has passed the late summer and early fall in this State



MAP SHOWING THE DISTRIBUTION OF RED FIR
EXPRESSED IN PERCENTAGES OF TOTAL FOREST IN WESTERN WASHINGTON.

SCALE

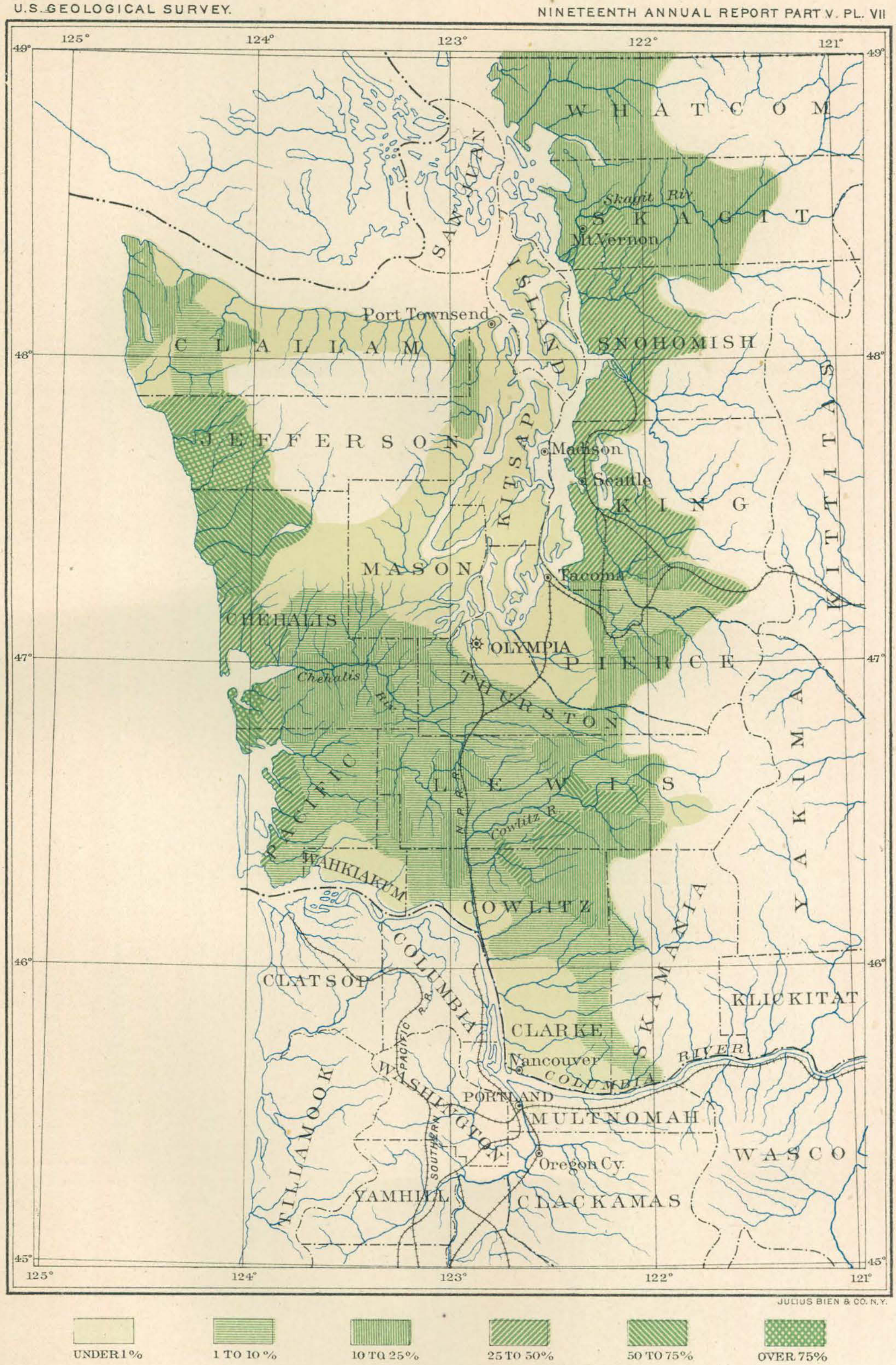
25 0 25 50 75 100 MILES



MAP SHOWING THE DISTRIBUTION OF HEMLOCK
EXPRESSED IN PERCENTAGES OF TOTAL FOREST IN WESTERN WASHINGTON.

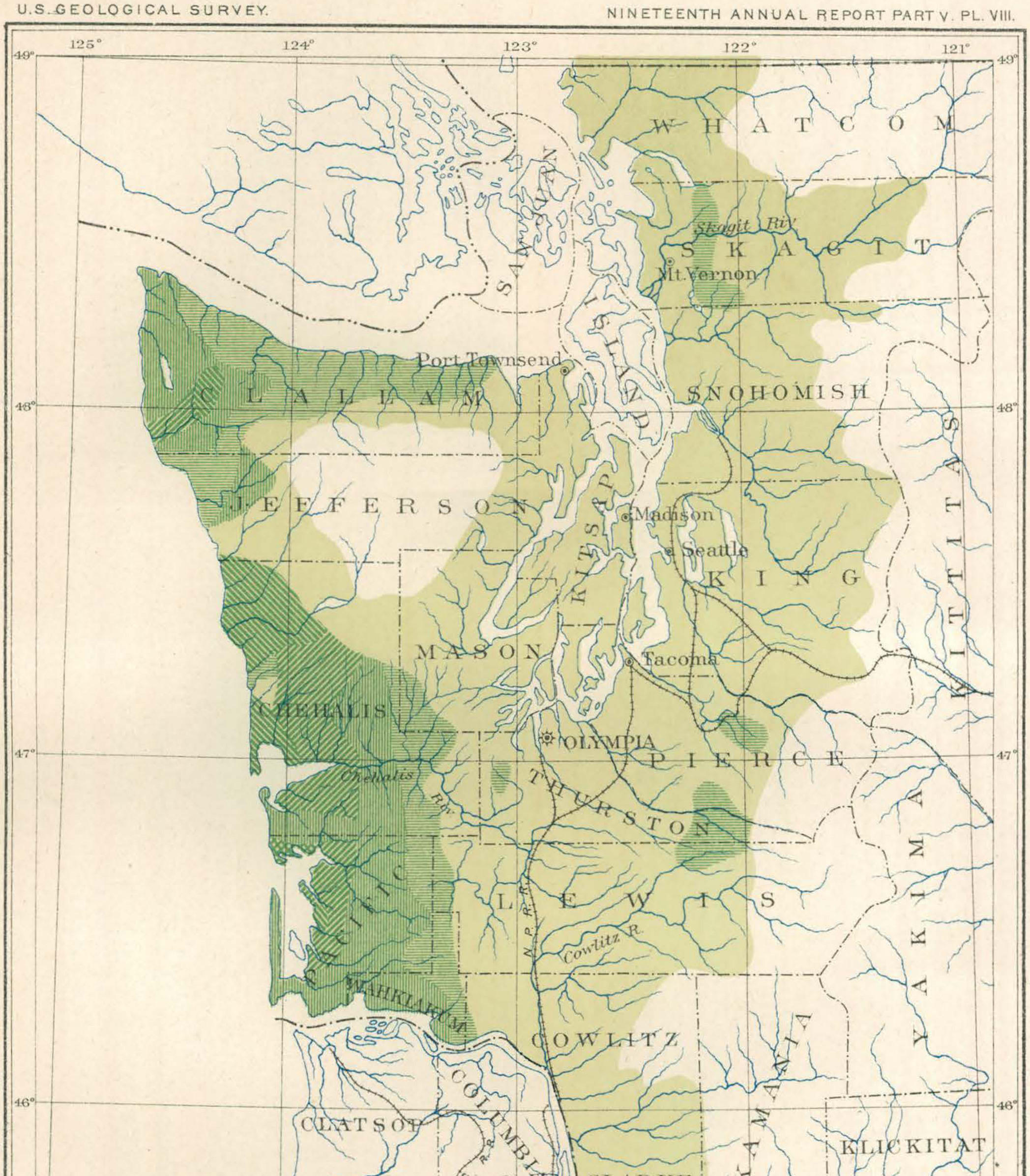
SCALE

25 0 25 50 75 100 MILES



MAP SHOWING THE DISTRIBUTION OF CEDAR
EXPRESSED IN PERCENTAGES OF TOTAL FOREST IN WESTERN WASHINGTON.

SCALE
25 0 25 50 75 100 MILES



MAP SHOWING THE DISTRIBUTION OF SPRUCE
EXPRESSED IN PERCENTAGES OF TOTAL FOREST IN WESTERN WASHINGTON.

SCALE 25 0 25 50 75 100 MILES

realizes the ernormous destruction which takes place annually at this season. There are fires everywhere, and the smoke from them lies as dense as the fog on the New England coast for weeks at a time.

These are impressive facts. In less than a generation more than two-fifths of the timber has been destroyed in one of the richest timber regions on this continent, and of that destruction more than half has been caused by fire. Nearly two years' supply of lumber for the United States has thus been destroyed. Assuming that the timber thus destroyed would, if standing now, have a value of 75 cents per thousand feet, it appears that not less than $30,000,000 worth has thus gone up in smoke—a dead loss to the people of the State.

The distribution of the different species recognized as lumber in Washington is represented on Pls. V–VIII, and is seen to follow a few definite and simple laws. The tints represent the proportion which each species bears to the entire forest, using the township as a unit. The map (Pl. V) showing the distribution of red fir shows that upon the west shores of Puget Sound the forest is practically pure fir, and that southward as far as Columbia River, throughout the valley of the eastern slope of the Cascade Range, more than three-fourths of the forest is composed of this species. The proportion diminishes as the Pacific coast is approached, and upon the coast, extending from 10 to 25 miles inland, there is practically no red fir to be found. On the east coast of Puget Sound and southward, between one-half and three-fourths of the forest is composed of fir. The proportion increases somewhat as we recede from the sound, but at an altitude of about 3,000 feet in the Cascade Range the fir suddenly disappears.

The distribution of spruce is expressed on the map (Pl. VIII) in a similar manner, and is equally characteristic. There is practically no spruce on the Cascade Range or on the eastern slopes of the Coast Ranges. It is most abundant immediately upon the Pacific coast, and diminishes thence inland.

Of cedar (Pl. VII) there is scarcely any to be found upon the islands and upon the west coast of Puget Sound, and but very little in the valley to the southward. It increases westward toward the coast and reaches a maximum immediately on the coast. The east coast of Puget Sound contains a large proportion of cedar, ranging from one-fourth to one-half of the forests, and that proportion diminishes as we ascend the Cascade Range.

Hemlock (Pl. VI) is almost entirely wanting upon both shores of Puget Sound and in the valley to the south. It increases westward and forms quite a noticeable proportion of the forests in the Coast Ranges and in the northwestern part of the Olympic Peninsula. It increases also as we ascend the Cascade Range, its habitat extending nearly to timber line.

Average stand of timber per acre on timbered areas.

County.	Feet B. M.	County.	Feet B. M.
Chehalis	21, 300	Pacific	16, 300
Clallam	15, 700	Pierce	18, 000
Clarke	19, 000	Skagit	28, 000
Cowlitz	20, 400	Skamania	17, 000
Jefferson	15, 300	Snohomish	19, 000
King	20, 500	Thurston	11, 450
Kitsap	9, 000	Wahkiakum	27, 000
Lewis	16, 500	Whatcom	24, 000
Mason	5, 600		

The stand is heaviest in Skagit County, near the northern boundary. The next heaviest is Wahkiakum, in the southwest, near Columbia River.

FOREST CONDITIONS AND STANDING TIMBER OF OREGON.

In order to obtain an idea of the amount of standing timber in the State, timber cruisings have been collected. The Oregon and California Railroad, now a part of the Southern Pacific, has a land grant extending along the whole line of its road from Columbia River to the California boundary, with a width upon each side of the road of 30 miles, including indemnity strips. Throughout this area the road received alternate sections of land, excepting such areas as had been alienated prior to the grant. The timber upon these lands has been examined by cruisers, and as the value of the land is determined by the amount of timber upon it, this was done with considerable care. Through the courtesy of the land agent, Mr. George H. Andrews, all this information in condensed form has been furnished to this office. The following data were obtained: In each township the amount of timbered and non-timbered land, and upon the timbered portion the amount of timber, expressed in feet B. M., distinguished according to the species of timber recognized by the cruisers. In this case the cruisers distinguish the following species: Fir, hemlock, cedar, sugar pine, yellow pine, noble fir, and spruce.

The following is a summary of the cruisings by this corporation:

Summary of cruisings by the Oregon and California Railroad Company in its land grant.

	Acres.
Total area examined	1, 442, 071
Timbered area	808, 003
Sparsely or not at all timbered	634, 068

Summary of cruisings by the Oregon and California Railroad Company—Continued

Variety.	M feet B. M.	Per cent of all.
Fir	10, 356, 430	81
Hemlock	761, 461	6
Cedar	213, 224	2
Sugar pine	325, 951	3
Yellow pine	1, 044, 050	8
Noble fir	58, 441	....
Spruce	31, 224	....
Total	12, 790, 781	100

These cruisings are scattered widely over the eastern portion of the coast ranges, the depression between the two ranges, which includes the Willamette, Umpqua, and Rogue valleys, and the eastern slope of the Cascade Range, and as they are in no way selected areas, but consist of alternate sections, without regard to the quality or density of the timber, they furnish an excellent representative of the distribution of the timber as to density and species over much of the timbered portion of Oregon.

Similar statistics were obtained from the Willamette Valley and Cascade Range Wagon Road Company from cruisings of its land grant, which consists of alternate sections for 6 miles on each side of the road. The total area of timber land cruised in this grant is 148,480 acres. The species distinguished, with the amounts of each and the total amount of timber upon the grant, are as follows:

Summary of cruisings by the Willamette Valley and Cascade Wagon Road Company in its land grant.

Variety.	M feet B. M.	Per cent of all.
Fir	1, 988, 287	85
Cedar	34, 978	1
Hemlock	150, 341	7
Yellow pine	66, 535	3
Larch	87, 893	4
Total	2, 328, 034	100

From Mr. W. S. Kinney, a prominent lumberman of Astoria, Oregon, I have received cruisings which he has had made of the northern half of Clatsop County. These cruisings do not distinguish among the different species of timber, but they show, upon an area of 268,000 acres, a total of 2,892 million feet of saw timber.

Mr. J. B. Leiberg, of this office, has made a thorough examination of an area of yellow-pine land situated east of the Cascade Range, upon the Paulina Mountains and the adjacent plateau at the head of Deschutes River, which, for an area of 500 square miles, he estimates at an average of 5,000 feet per acre.

The above figures summarize the extent of definite information which we have concerning the density of the forests. Although in the aggregate the area included in these cruisings is small as compared with the total wooded area of the State, yet they are scattered so widely that the entire western portion is sampled quite thoroughly, and from them a tolerably correct idea may be obtained of the density of the forests in the most important timber portions of the State—i. e., the Cascade and Coast ranges.

These figures indicate for the Coast Ranges and the timbered portions of the west side of the valley an average of 16,000 feet B. M. per acre; for the western slope of the Cascades and the eastern part of the valley an average of 14,000 feet per acre; for the eastern slope of the Cascades the average is about 6,000 feet. In the eastern portion of the State no data have been obtained, but from impressions of those who have traveled through the forests of the Blue Mountains and other ranges it is believed that they will average not far from 1,500 feet per acre. From these data the following table has been prepared, showing the amount of timber in these different sections of the State and in the entire State:

Estimated amount of timber in Oregon, by sections of the State.

	Stand per acre.	Timbered area (square miles).	Amount of timber (million feet B. M.).
Coast ranges	16,000	10,000	102,108
West slope Cascade Range	14,000	9,900	87,083
East slope Cascade Range	6,000	7,100	27,534
East Oregon	1,500	18,441	17,928
Total			234,653

The following table gives estimates by counties:

Estimated amount of timber in Oregon, by counties.

County.	Area (square miles).	Timbered area (square miles).	Average timber contents (feet B. M. per acre).	Total amount timber (million feet B. M.).
Baker	2,160	1,200	1,500	1,200
Benton	684	180	15,000	1,728
Clackamas	1,836	1,330	15,700	13,338
Clatsop	815	651	36,800	15,476

Estimated amount of timber in Oregon, by counties—Continued.

County.	Area (square miles).	Timbered area (square miles).	Average timber contents (feet B. M. per acre).	Total amount timber (million feet B. M.).
Columbia	693	552	27,700	9,683
Coos	1,620	1,295	15,600	12,926
Crook	8,352	3,750	3,200	7,300
Curry	1,440	1,080	11,400	8,000
Douglas	4,752	3,600	10,400	23,854
Gilliam	1,728	400	1,500	400
Grant	5,436	4,700	1,500	4,700
Harney	9,482	1,150	1,500	1,150
Jackson	2,376	1,620	11,600	12,000
Josephine	1,764	1,514	6,000	5,800
Klamath	6,200	3,420	6,300	13,834
Lake	8,000	2,000	1,500	2,000
Lane	4,356	3,420	13,000	28,800
Lincoln	1,000	612	25,000	9,800
Linn	2,268	1,620	17,600	18,300
Malheur	9,828	1,000	1,500	1,000
Marion	1,224	576	12,600	4,645
Morrow	2,070	470	1,500	470
Multnomah	440	96	21,000	1,300
Polk	684	400	13,000	3,328
Sherman	....	(*a*)	....	....
Tillamook	1,116	864	26,000	14,490
Umatilla	2,968	1,300	1,500	1,300
Union	3,312	2,200	1,500	2,200
Wallowa	2,808	2,808	1,500	2,808
Washington	684	350	20,000	4,500
Wasco	3,200	1,116	10,000	7,100
Yamhill	720	167	11,400	1,223
Total	....	....	....	234,653

a No timber.

In western Oregon the merchantable timber consists of much the same species as in Washington, viz, the Douglas or red fir (*Pseudotsuga taxifolia*), Sitka spruce (*Picea sitchensis*), cedar (*Thuja plicata*), and hemlock (*Tsuga mertensiana*). Besides these there are found in the southwestern part of the State sugar pine (*Pinus lambertiana*), noble fir (*Abies nobilis*), and yellow pine (*Pinus ponderosa*).

As is seen from the cruisings, a vast majority of all the timber in this part of the State consists of red fir. Cedar and hemlock are comparatively unimportant and spruce is not represented in the cruisings, although it is known to be abundant along the coast where these cruisings do not extend. Sugar pine, noble fir, and yellow pine form but a trifling proportion of the lumber of this part of the State.

Pls. X–XIII show the distribution of fir, hemlock, cedar, yellow pine, and sugar pine. The distribution of the first three named is expressed on these maps in percentages of the total forest. The range of the last two species is represented by lines limiting it.

It will be seen that fir occupies the entire timbered portion of the depression between the Coast and Cascade ranges, with the eastern slope of the former and the western slope of the latter. Throughout most of this area it forms more than three-fourths of the forest, but becomes less in proportion near the southern boundary of the State.

The distribution of cedar corresponds in this State to its distribution in Washington, there being none in the valley, while upon the Coast Ranges and the Cascade Range, at middle altitudes, it forms a small proportion of the forest. It increases in proportion as the shores of the Pacific are approached.

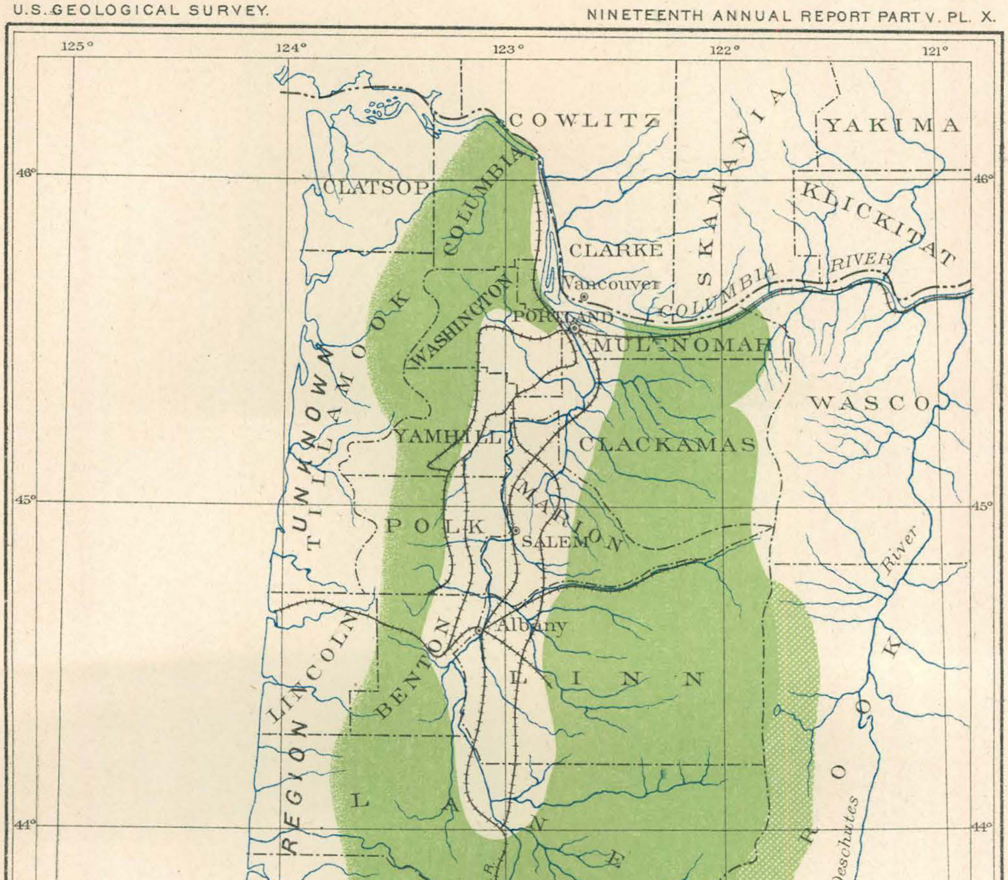
The distribution of hemlock in western Oregon is similar to that in western Washington, there being none in the valley, while upon the west slope of the Cascade Range it forms a notable proportion of the forest, reaching its maximum at mid altitudes. In the Coast Ranges it forms also a notable proportion of the forest, and probably increases toward the coast.

The forests of Oregon east of the Cascade Range are composed largely of yellow pine. This species crosses the range a little north of latitude 44°. Here, as is indicated by the map, the western limit crosses the range and immediately runs northwestward down its slopes, then, turning to the south and southwest, it crosses the valley just south of Roseburg and passes into the Coast Ranges. For its farther extension southward and westward I have no data.

Sugar pine enters the State from California, extends northward over the entire breadth of the Cascade Range, and probably nearly to the coast, its northern limit running as far north as the latitude of Oakland.

In conclusion, it will be instructive to add the following estimate of the timber of Oregon, made in 1895 by Mr. W. T. Griswold, of this office:

The following estimate of the timber of the State of Oregon is made from personal observation during the past five years, and a vast amount of important information from cruisers' reports, loggers, and manufacturers of lumber in different parts of the State. In such areas as I have had reliable information I have made a summation of the estimated amount of timber in each township, finding them to run from 50,000,000 to 800,000,000 feet to the township, board measure, and finding from these results that a generally good timbered area will give an average of 12,000,000 feet for a section, or 432,000,000 to the township. I have completed my summation for those areas in which I know the limits, but have no information as to the quality and amount of timber, using this number as to the amount per township.

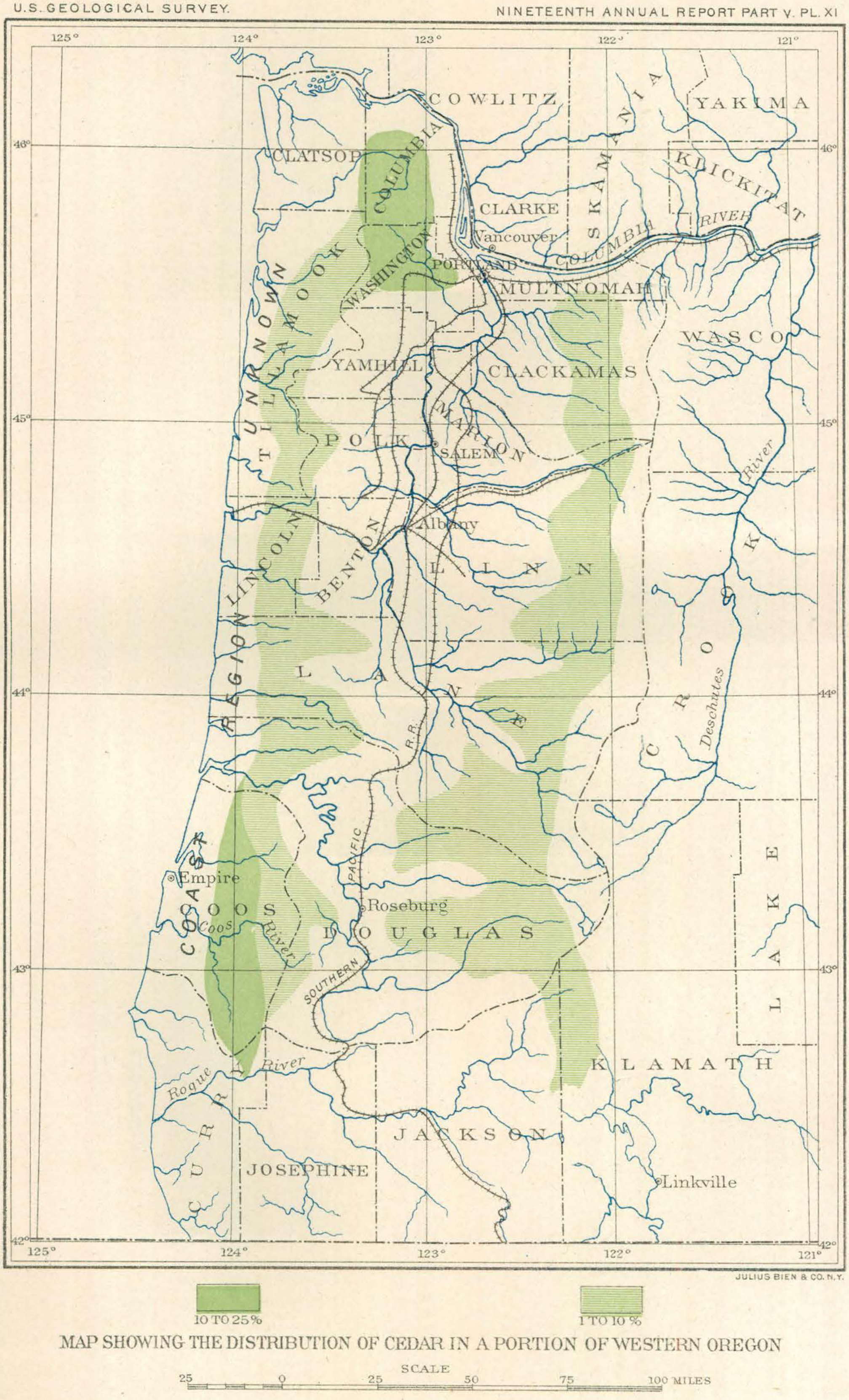


OVER 75% | 50 TO 75% | LESS THAN 50%

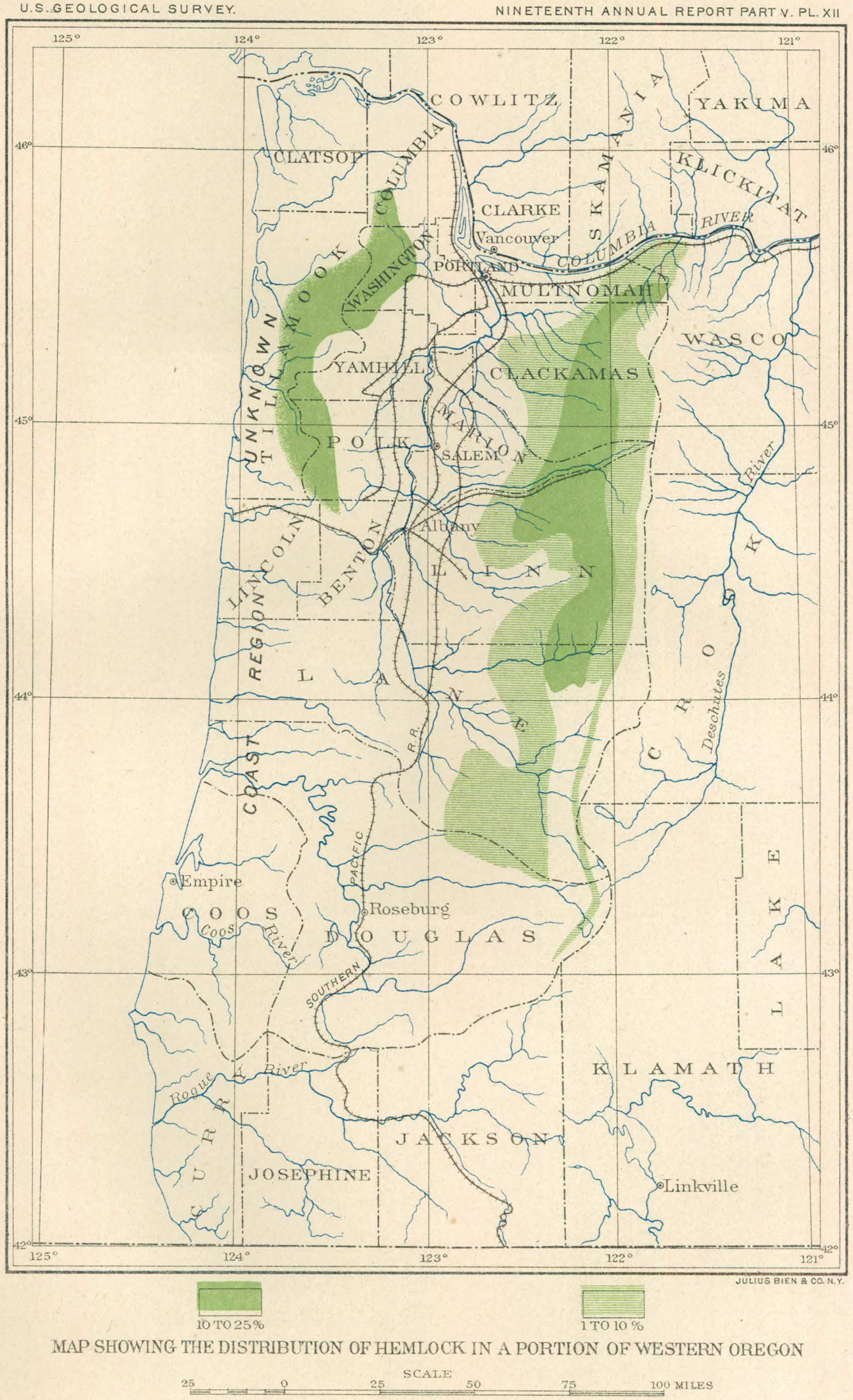
MAP SHOWING THE DISTRIBUTION OF FIR IN A PORTION OF WESTERN OREGON

SCALE

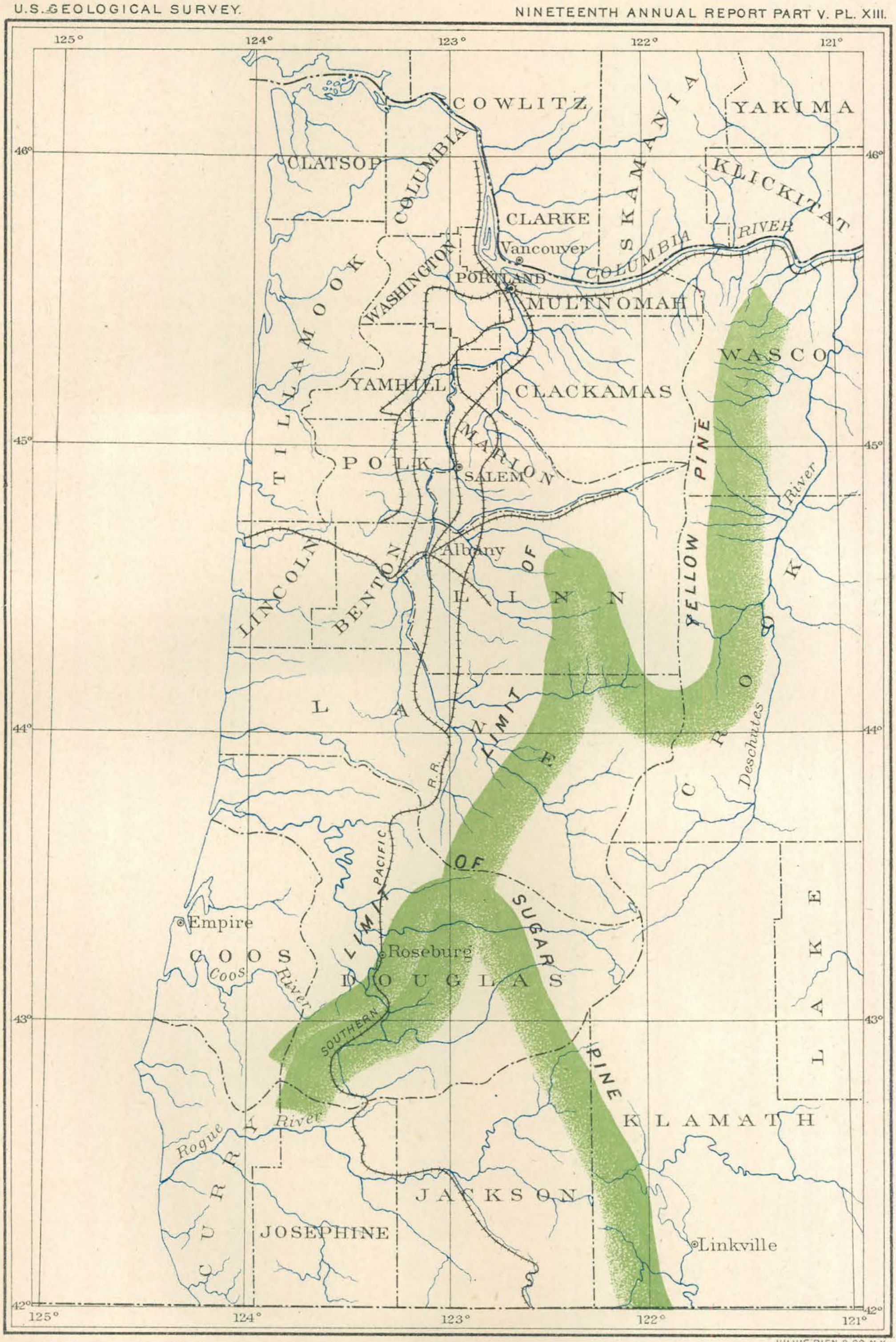
25 0 25 50 75 100 MILES



MAP SHOWING THE DISTRIBUTION OF CEDAR IN A PORTION OF WESTERN OREGON



MAP SHOWING THE DISTRIBUTION OF HEMLOCK IN A PORTION OF WESTERN OREGON



MAP SHOWING THE LIMITS OF YELLOW PINE AND SUGAR PINE IN A PORTION OF WESTERN OREGON

SCALE

25 0 25 50 75 100 MILES

From this we get a result of 200 billion feet of standing timber in the State, distributed as follows:

	Feet.
Clatsop and Columbia counties, coming into the Columbia River	8,000,000,000
Nehalem River	17,000,000,000
Tillamook Bay	6,000,000,000
Tillamook Bay to Smith River	5,000,000,000
Smith River and the Lower Umpqua	4,500,000,000
Coos Bay and Coquille River	18,000,000,000
Bullrun Reserve, coming into the Columbia by way of the Sandy River	7,000,000,000
Clackamas and Santiam rivers	29,000,000,000
McKenzie and waters of the Willamette	38,000,000,000
Umpquah in the Cascades	26,000,000,000
Rogue River in the Cascades	22,000,000,000
Scattering, small bodies over the State	2,500,000,000
Pine in Blue Mountains, eastern part of State	4,000,000,000

As will be seen, Mr. Griswold's estimate for the Cascade Range and the country west thereof is somewhat larger than mine, while his estimate of the timber in the Blue Mountains and upon the plateau east of the Cascades is very much less. From a somewhat extended acquaintance with this region, I am satisfied that his figures concerning it are entirely too small.

SAN FRANCISCO FOREST, ARIZONA.

The Territory of Arizona is composed of two parts, differing greatly from each other in altitude, and consequently in climate. The northern and eastern portion consists of a plateau ranging in altitude from 6,000 to 8,000 feet. The southern and western portion is low, ranging from near sea level up to 4,000 or 5,000 feet. The southern and western edges of this great plateau, the Colorado Plateau, are well defined, and in the eastern portion are known as the Mogollon Mountains. This escarpment runs from the east line of Arizona, near its middle point, westward and northwestward, and finally north to the Colorado Canyon. In the southwestern part of this plateau is a group of mountains, known as the San Francisco Mountains, which rise to an altitude of nearly 13,000 feet. A forest surrounds the base of these mountains, stretching thence to the escarpment and down it nearly to its foot. This forest accompanies the escarpment southeastward to the Territorial boundary, extending nearly to the foot of the escarpment on the south, and on the north spreading a variable distance into the plateau. This forest extends in a northwest-southeast direction for a distance of over 200 miles. Its greatest breadth in a contrary direction is about the San Francisco Mountains, where it reaches nearly 50 miles, while in other parts the breadth ranges from 12 to 25 miles. Altogether it occupies an area of 4,700 square miles, or, approximately, 3,000,000 acres.

This is, from all points of view, the finest forest in the Southwest. It is composed of an almost pure growth of yellow pine (*Pinus ponder-*

osa). Upon San Francisco Mountain, at certain altitudes yellow pine gives way to red fir, and still higher to subalpine species, but the area occupied by them is trifling compared with the total extent of the forest. It is throughout an open forest, with little or no undergrowth, the trees standing far apart. They are of good size for lumber purposes, clear of branches, and with long, straight stems. It has been remarkably free from fires, a fact doubtless due in great part to its open character and freedom from underbrush.

Concerning the amount of timber contained in this forest, I have secured cruisings made by the Atlantic and Pacific Railroad Company upon a portion of their grant, which covers parts of this forest. The area cruised is in the western portion, in the neighborhood and south of Flagstaff. The timber has been estimated upon portions of twenty-five townships, an area of 214,000 acres altogether. Upon this area the stand was estimated to be 572,700,000 feet B. M., giving an average stand per acre of 2,700 feet. From such information as I have been able to gain the average stand of timber in other parts of the forest does not differ materially from that of the portion examined. If this be so, the forest contains a little more than 8,000 million feet of lumber.

SUMMARY OF FIELD WORK AND ABSTRACTS OF REPORTS.

During the season of 1897 examinations were made of the forests upon the following reserves:

The Black Hills Reserve of South Dakota and Wyoming, by H. S. Graves; the Bighorn Reserve, Wyoming, by F. E. Town; the Teton Reserve and the southern portion of the Yellowstone Park Reserve, by Dr. T. S. Brandegee; the Priest River Reserve, Idaho, and the eastern portion of the Bitterroot Reserve in Montana and Idaho, by Mr. J. B. Leiberg; and the Washington Reserve, Washington, by Messrs. H. B. Ayres, W. G. Steele, and M. W. Gorman. Their reports upon these reserves form the greater portion of the present volume. During the spring of 1898 Mr. Leiberg examined the San Jacinto, San Bernardino, and San Gabriel reserves, of southern California, and his preliminary report is presented herewith.

The instructions under which these examinations were made differed somewhat in the case of different reserves, but were substantially as follows:

> The information desired may be summarized as follows: The delimitation upon maps of the wooded area and of the area occupied by merchantable timber. The amount of the latter, expressed in feet B. M., should be represented upon the map in grades, as follows:
>
> (1) Under 2,000 feet per acre.
> (2) 2,000 to 5,000 feet per acre.
> (3) 5,000 to 10,000 feet per acre.
> (4) 10,000 to 25,000 feet per acre.
> (5) 25,000 to 50,000 feet per acre.
> (6) 50,000 to 100,000 feet per acre.
> (7) Over 100,000 feet per acre.

All the above data may be represented upon one map, and the larger scale should be used. Upon other copies on the smaller scale you will represent the extent of each of the most valuable timber trees, such as Western white pine, tamarack, cedar, and spruce.

Notes should be made, preferably upon maps, of the areas which have been cut over or culled, with a memorandum of the species cut; of areas burned over, with memorandum of the damage inflicted.

Notes on the following subjects should accompany the maps above specified.

The character of the soil.

The forest litter.

Depth of the humus.

The character and density of the underbrush and young growth.

The range in size of the trees of the principal different species.

The total height, clear trunk, and apparent age and soundness.

The effect of fires on the reproduction of trees.

The proportion of dead standing timber.

The character of the cutting, by whom, and for what purpose.

The means of transportation of lumber in and out of the reserve, streams, roads, etc.

The character and extent of the local demand for lumber.

The effect of sheep pasturage on reserve.

The use of water for irrigation and milling.

The extent and distribution of land more valuable for agriculture than for timber.

BLACK HILLS RESERVE.

Mr. H. S. Graves commenced work early in July and concluded in the latter part of November, having examined the entire region of the hills, including much land outside the limits of the reserve. Topographic maps of this region, made on a scale of 1:125,000, by the Survey, are used for the representation of much of the data obtained.

The area of the reserve, which lies entirely in South Dakota, is estimated at 967,680 acres, or about 1,500 square miles. It includes practically all the forests of the hills to the east, but on the north and northwest there are large areas of forest which are not included. On the other hand, in the southwestern part there are large tracts of open country which are included in the reserve.

The Black Hills are situated between the Belle Fourche and the South Fork of Cheyenne River, between the forty-third and forty-fifth parallels of latitude and between the one hundred and third and one hundred and fifth meridians. They are an isolated group of mountains, whose general trend is NNW.-SSE., and are about 120 miles long by 40 miles in width. The form of the uplift is elliptic. From the central portion the stratified beds have been in part removed, exposing the underlying granites in the eastern half, while the western half is still covered by Carboniferous limestones. The granite portion is somewhat rugged, although the relief is on a small scale. The Carboniferous portion has an undulating surface.

Entirely surrounding this central portion is an elliptic-shaped valley of varying breadth, known as the "Race Track." This in turn is inclosed by a rim of ridges, or hogbacks, ranging in elevation from 200 to 800 feet above the plains. The mean altitude of the plains at the base of the hills is about 3,000 to 3,500 feet above sea level, and the average elevation of the hills above them is about 2,000 feet. The highest point is Harney Peak, in the granite portion of the hills, which has an altitude of 7,215 feet above sea level. In the northwestern portion of the hills are several isolated peaks of volcanic rock which have broken through the overlying strata, and, owing to their greater hardness, they have remained while the softer strata have been worn away.

The exterior outlines of the main body of forest are, for the most part, sharply drawn. In general the forest terminates abruptly at the inside of the Race Track, or the broad valley lying between the main portion of the hills and the hogbacks which encircle them. In certain cases where these hogbacks are higher than elsewhere they also are clothed with forests. Thus the Elk Mountain Range, the Pisgah Hills, the Inyankara Range, and the Bear Lodge Mountains are covered with timber. In the southern portion of the hills the outline of the timber is more irregular than elsewhere and has been pushed back within the hills by forest fires.

In general the timber is dense, but the forest is broken in many places by parks and mountain prairies, and enormous tracts have been denuded by recent forest fires. The entire area within the exterior limits of timber is about 2,600 square miles. Of this 2,000 square miles are covered with forest, the rest being either parks or prairies or covered with a scattered growth of young timber.

The amount of merchantable timber within the Black Hills is estimated at 1,440 million feet B. M. Besides this, it is estimated that the hills contain 13,150,000 cords of firewood, poles, ties, etc.

The only tree in the Black Hills of commercial importance is the yellow pine. The other species are so small, occur in such limited numbers, or have so few uses that they are of little or no economic importance.

The forest, as it is found to-day, does not represent at all what the yellow pine is capable of producing in this region. The forest is irregular and broken and is composed in many places of defective and scrubby trees. There are trees of every age and class, and there are large areas where there are no trees at all. For a pure pine forest the yield in merchantable timber is extremely small. In some places it will yield 15,000 to 20,000 feet per acre, but such localities are small in area. In general a district which will yield 5,000 feet per acre over the whole area is very good, and the average yield of the forested regions is probably not over 4,000 feet. For this condition forest fires are directly responsible, and the present aspect of the forest is the result of long abuse and the struggle of the forest to reestablish itself. The broken condition of the forest, the large proportion of defective trees, the many wind breaks, the prairies, parks, and bald ridges, are due to the destructive forest fires which have swept the hills periodically for years and probably for centuries.

The natural forest of yellow pine is dense and composed of trees of about the same age. It often comes up in bodies, the trees of which, over considerable areas, have the same age, and the irregular conditions now found are due entirely to external influences. The original forest, uninfluenced by fire or windfall, is found in but few places in the Black Hills. Such localities are distinguished on the map as those of the heaviest growth. They are found on rich soil and in protected situations. The trees average about 20 inches in diameter, with a maximum of 3 feet. This timber reaches a height of from 80 to 100 feet, and the stems are straight and clear of limbs for from 30 to 50 feet.

There is a large amount of young growth scattered throughout the original forest, and in the northern part of the hills the timber is composed almost entirely of second growth, i. e., of thrifty growing trees not yet large enough for lumber.

Although the plains surrounding the Black Hills are within the arid region, having a rainfall of less than 20 inches annually, the Black Hills, by virtue of their greater altitude and broken character, enjoy a greater rainfall, giving them a subhumid climate. In some years there is sufficient rainfall for the maturing of crops, and in others there is drought, consequently the practice in regard to irrigation is by no means uniform. Some farmers prefer to irrigate, and thus insure their crops, while others take the chances on the rainfall. In some localities the soil is more moist than in others and irrigation is unnecessary in the majority of seasons, while in other and drier localities the reverse is the case. Hence it is difficult to say whether the criterion of agricultural land should be the ability to irrigate it. It therefore seems best to point out the areas of open valley country within the reserve. These open valleys are scattered all over the reserve, intersecting bodies of timber in narrow strips, but nowhere appearing in large bodies except in the southern part of the reserve, where there is an area, comprising several townships, of open country containing but little timber, and that in small groves and patches.

The reserve is traversed by a branch of the Chicago, Burlington and Quincy Railroad, and on this road there are several towns of considerable size, including Custer, Hill City, Rochford, and others. The ranches upon the reserve are estimated to number 450 to 460. Most of these have been taken up as placer claims. These ranches contain on an average from 30 to 40 acres of plow land each. The chief products are oats, hay, and vegetables.

Such open country as above described, where not available for farming, furnishes excellent pasturage. The largest extent of this is the great area in the southern part of the hills mentioned above. It is estimated that there are about 5,000 head of stock ranging through the timbered part of the hills, including the small bunches of cattle and horses owned by the ranchmen. There are no sheep pastured within the hills. It is stated that pasturing of cattle and horses does no harm to the forests.

Mining is the most important industry in the hills, and in the northern portion, north of the reserve, probably not less than two-thirds of the population are supported directly or indirectly by the mines. The principal mining center is the vicinity of Lead and Deadwood, where the Homestake mine is located. There are a number of other small mining towns in the neighborhood, and throughout this portion of the hills are scattered mining camps whose inhabitants are prospecting and are developing discoveries. The most important mineral belt in the central hills is at Keystone, where the Holy Terror and Keystone mines, employing a large number of men, are located, and throughout the eastern portion of the Black Hills are scattered small mines and discovery pits. They are said to be valuable, but are not being operated beyond the performance of the work required by law to hold the claims.

As stated above, the hills have been frequently and greatly devastated by fires. To the prevalence of the latter is doubtless due the existence of the open, park-like areas in the forest, as well as the poor quality of much of the timber, and the young growth, which covers great areas.

The vast majority of fires are doubtless the result of carelessness on the part of camping parties. Incendiary fires are not common. Some fires are set by sparks from railway trains and some by lightning. Many fires have been set by the burning of brush after clearing, though these are not so common as formerly. In the early days, before the occupation of the region by whites, doubtless fires were set intentionally by Indians to drive game or to improve the pasturage.

There are forty-two small mills in operation in the South Dakota portion of the Black Hills. These are small, portable mills, capable of cutting, as a rule, about 8,000 or 10,000 feet of lumber each per day when in full operation. Very few of them, however, are run to their full capacity. The total annual output of lumber is estimated at 20,000,000 feet, besides the amount cut for firewood. Most of this is cut for mine timbering in the Homestake and other mines, but no small proportion of it is exported from the State.

BIGHORN RESERVE.

Mr. F. E. Town commenced work about the middle of July and ended at the close of September.

The limits of the reserve conform in a general way to the outlines of the Bighorn Range, although not closely. In some places they inclose small areas of the plains upon the east and west, while in others considerable mountain and forest areas are excluded. The range, however, extends far to the south of the southern limit of the reserve. The area of the reserve is 1,198,080 acres, or 1,870 square miles.

The Bighorn Range has the form of an ellipse, the axis of which is somewhat curved, trending in the southern part nearly north and south and in the northern part to the northwest. The breadth ranges from 30 to 50 miles and the length is between 75 and 100 miles. On the east are the plains and on the west is the Bighorn Basin. Structurally the range consists of a great anticlinal fold, broad, flat, and rising steeply upon the flanks. The country on either side has an elevation of 4,000 to 5,000 feet above sea level, while the summit of the range has an altitude for the most part of 7,500 to 9,000 feet. In general, the summit of the range is a plateau whose surface is undulating and hilly and presents comparatively little relief; but here and there rise granite summits to altitudes exceeding 10,000 feet, and about the middle of the plateau there rises a range of mountains 3,000 to 4,000 feet above its surface, or 12,000 to 13,000 feet above the sea, the highest summit of this range being Cloud Peak, with an altitude of 13,100 feet.

While the entire area of the Bighorn Mountains, with the exception of a small region above timber line, is, judging from its climate and other indications, capable of producing forests, the general aspect of the reserve is that of a lightly timbered region. It contains no large or valuable timber. It is only in a very few localities that any timber suitable for the sawmill is to be found, and a large proportional area, probably quite one-half, consists of open parks. Nearly all of the timbered region has been burned over, and much of it has been repeatedly subjected to devastation from fires. In the park areas it is evident that the timber has been driven out completely by fire. Of the timbered region a large part is covered with young growth, ranging from 10 to 50 years of age, while the ground is strewed with dead trees, the victims of fires, and these dead trees also are young and small. Fires have prevailed so frequently and universally over this region that it is only in limited localities that mature forests exist.

The destruction of the forests dates back mainly to the time of the occupancy of this region by Indians, and the fires were doubtless set by them for the purpose of driving out game or improving the pasturage. Since the occupancy of this region by whites fires have been few and small.

Almost all the timber of this reserve consists of lodgepole pine (*Pinus murrayana*). This is generally distributed over the reserve at all altitudes, from the level of the plains to timber line. It is an inferior wood for lumber purposes.

Other species of coniferous trees—*Pinus flexilis*, *Picea engelmanni*, and *Pseudotsuga taxifolia*—are found, but they are sparsely distributed.

One of the best bodies of timber in the mountains is located in T. 55 N., R. 88 W., which was left out of the reserve, probably because a portion of its area had passed into private hands. The township north of this also contains considerable timber. South of the line of the reserve, T. 47 N., in Rs. 84 to 87, inclusive, is fairly well timbered; indeed, quite as fully as the region lying adjacent within the reserve.

It is estimated that in the entire reserve there are only 106,000 acres upon which the timber is of sufficient size to be considered merchantable, and of this about 22,000 acres have been cut over for railroad ties, leaving, approximately, 84,000 acres not cut over. Upon this area it is estimated that there are at present 210,000,000 feet B. M. of standing timber. This statement summarizes the condition of things upon the reserve. Its entire area is capable of producing timber, but of this area only 7 per cent contains merchantable timber at present.

There were, during the summer of 1897, six sawmills using timber from the reserve. These mills cut 1,700,000 feet B. M. per year. In recent years about 1,750,000 railroad ties have been cut from Ts. 55 and 56 N., R. 88 W. This represents about 56,000,000 feet B. M. The above figures represent the extent of timber cutting within these mountains, with the exception of the small amount cut by settlers for their improvements and for firewood.

Roads across and through these mountains are few in number. There are very few settlers and improvements.

The Bighorn Mountains are used very extensively as a summer range for sheep. It is estimated that during the summer of 1897 450,000 sheep were pastured upon them. At present their range is confined to the parks, the adjoining timbered areas being untouched by them; therefore at present there is no question concerning any injury to the forests by them.

There has been some prospecting for minerals in these mountains for several years, but few discoveries have been made which have shown sufficient promise to induce regular work. Some mining has been done upon Bald Mountain, near Cloud Peak, near Black Mountain, on Tongue River, and on Wolf Creek. On the whole, however, the mining industry is at present a trifling matter.

There is no arable land within the limits of the reserve. Although there is an abundance of open country and of water for irrigation, the altitude is so great, and consequently the climate is so severe, that the cultivation of any but the hardiest crops is impracticable.

TETON AND SOUTHERN PART OF YELLOWSTONE PARK RESERVE.

Dr. T. S. Brandegee commenced work about the 1st of July and concluded about the end of September.

Topography.—The principal relief features are simple. Traversing the reserve from north to south, near its western boundary is the Teton Range. This has an average breadth of 12 to 15 miles, and is extremely rugged, rising in the highest summit, the Grand Teton, to an altitude of 13,876 feet, while the average altitude of the range is probably not far from 12,000 feet. On the west the mountains descend quite steeply to Teton Basin, across the eastern upper edge of which runs the west boundary of the reserve, at an altitude of 6,500 to 7,000 feet. On the east the Teton Range descends by cliffs and extremely steep slopes to the valley known as Jackson Hole. This is a broad expanse, extending from the north boundary of the reserve in a direction a little west of south to the southern boundary. Its breadth ranges from 10 to 12 miles, and its altitude within the reserve from 6,500 to 7,000 feet. It is drained by Snake River, which traverses it from north to south, receiving the waters of several large branches from the east, including Buffalo and Gros Ventre rivers. There are several lakes in the valley, the largest of which is Jackson Lake, near the north boundary of the reserve, through which flows Snake River. The surface of the valley is in the main a gravelly bench land, quite level, and producing a scanty growth of sagebrush interspersed with grass. The bottom land of the river is broad and inclosed between low bluffs. It is covered with a dense growth of cottonwoods, willows, and brush.

The country east of Jackson Hole consists of high, massive mountain spurs, descending from a high plateau, 11,000 to 12,000 feet in altitude, whose crest lies east of the reserve. In this plateau head Pacific Creek, Buffalo River, and the Gros Ventre, which flow westward, through narrow valleys, to the Snake.

Forests.—The broad, rugged summit of the Teton Range is without forests, partly because of its great altitude and partly because of its extremely rugged character. The small portion of the Teton Basin which is within the reserve, and most of the area of Jackson Hole, together with the lower portions of the narrow valleys of Buffalo and Gros Ventre rivers, are also naturally treeless. The remaining portion of the reserve is covered, but more or less sparsely, with timber growth. In few localities is the timber such as could properly be called dense, and the trees are nowhere large. Over most of this area the timber is scattered in small groves, interspersed among open, park-like areas. Four-fifths of the timber consists of lodgepole pine (*Pinus murrayana*), the remainder of Engelmann spruce, red fir, juniper, and aspen. The trees are small and of little service for any purpose other than firewood, fencing, and such uses. Thus, although the entire area in which timber is found is well adapted in climate and soil to timber growth, the amount of timber contained upon it at present is trifling. All indications point to fire as the cause for this condition of things. It is evident that in times past this region has been devastated by fire so frequently that forest growth has been well-nigh prevented. The proof of this is seen in the existence everywhere of dead and charred stumps of trees and fallen logs, and in the fact that over great areas young timber is starting.

Upon the whole reserve it is estimated that there are not over 22,000 acres of merchantable timber—that is, of size suitable for saw logs—and that they contain not over 75,000,000 feet B. M. of lumber. These areas are scattered widely over the reserve.

Agricultural lands.—As stated above, the west boundary includes a small area of the upper part of Teton Basin. This is a triangular tract, widest at the north, where it may be 6 miles in width, and diminishing southward to a point. Nearly all of T. 45 N., R. 118, is within this area; also the west half of T. 44 N., R. 118; and the western tiers of sections in T. 43, R. 118, are included within it. Although elevated and cold, and therefore capable of producing only the hardiest crops, this land is susceptible of irrigation and cultivation.

Jackson Hole comprises a large amount of agricultural land. Its situation is favorable for irrigation, and the supply of water is ample for the entire area. The altitude, however, is high, and the consequent severity of the climate will prevent the production of anything except the hardiest vegetables and grains. Its value as agricultural land is not, therefore, great. The area included in this valley is as follows:

In R. 113 W., the three western tiers of sections of T. 46 N. and the south half of T. 45 N.

In R. 114 W., the north half of Ts. 46, 45, and 44.

In R. 115 W., the west half of Ts. 46, 45, 44, and 43.

In R. 116 W., the two eastern tiers of sections of T. 44 and the east half of T. 43.

The above tracts comprise all the land within the reserve which can be classed as agricultural.

Settlement.—There are within the reserve 40 ranches, of which 19 are in the Teton Basin, at the west foot of the Teton Range, the remaining 21 being in Jackson Hole. They are for the most part only hay ranches. On each of them are kept a few head of cattle, which range in summer and are fed wild hay in the winter. No attempt, so far as known, has been made to cultivate crops in either locality. The stock kept in Jackson Hole are few in number and their range thus far has been limited to the valley. There are no sheep ranged within the reserve.

Two sawmills are in operation cutting timber within it. Both are small and are located at the west base of the Teton Range, one upon the creek flowing west of Teton Pass, the other upon Darby Creek.

Settlements in the neighborhood of this reserve being extremely sparse, there is scarcely any demand for lumber, and none may be anticipated in the immediate future.

The only means of communication are by wagon road and trails. The only wagon road of importance within the region is that which, coming from the west, crosses the Teton Range at Teton Pass, and, descending to Jackson Hole, follows up Snake River into Yellowstone Park, with a branch leading over the divide at Grassy Lakes and down Falls River.

BITTERROOT RESERVE.

The area of the reserve is 6,480 square miles, or 4,147,200 acres, of which 3,456,000 are in Idaho and 691,200 are in Montana.

Only a portion of this reserve was examined in detail, consisting of the Montana part, together with a small area upon Magruder Fork of Clearwater River.

Topography.—The State line between Montana and Idaho follows the crest of the Bitterroot Range, a broad and rugged mass of mountains, rising to altitudes of 6,000 feet in the passes and to 10,000 feet on the highest peaks. The descent on the east is short and abrupt to the valley of Bitterroot River. Upon the west the spurs are long and the streams flowing westward into the Clearwater are, in the main, in deep canyons.

The east boundary of the reserve as at present established crosses during the most of its course the mountain spurs and gorges just above the Bitterroot Valley, but near the south end of the valley the reserve is extended eastward, so as to include the drainage area of the South and West forks of the Bitterroot. Here the stream is divided into several branches, these being in narrow valleys separated by spurs of considerable height.

Upon the west side of the divide, in Idaho, the country so far as examined consists of an alternation of high mountain spurs and deep narrow gorges.

Forests.—At great altitudes and upon the sides and summits of the rocky spurs the forests are scanty and poor. It is only in the lower country, especially in the upper valleys of the branches of the Bitterroot, in the canyons of its tributaries farther north, and on the lower slopes of the mountains, that forests of economic value are found. There may accordingly be distinguished two zones of forest distribution, depending upon altitude. The lower of these may be distinguished as the yellow-pine zone, the upper as that of the alpine-fir zone. The areas occupied by these two zones constitute, respectively, 26 per cent and 74 per cent of the Montana portion of the reserve.

The timber in the yellow-pine zone consists mainly of red fir and yellow pine in the proportion of 60 per cent and 30 per cent, the remainder being of other and less valuable species. In the subalpine zone nine-tenths of the timber consists of lodgepole pine, which is of little commercial value. The heaviest and most valuable stands of timber are found upon the upper waters of Bitterroot River, in the southeastern part of the reserve.

The total amount of merchantable timber in the Montana portion of the reserve is estimated at 554,500,000 feet B. M., including in this only that which is suitable for saw purposes. This consists entirely of yellow pine and red fir. No estimate has been made of the amount of lodgepole pine, as this is of little value for lumber purposes, since it is situated in inaccessible localities.

Outside the reserve, on the bench lands in the Bitterroot Valley adjoining the reserve, is a large amount of timber, estimated at 467,000,000 feet, or an amount nearly equal to that included within the Montana portion of the reserve.

Upon the Idaho side of the divide there was examined an area of about 650 square miles. Similar zones of timber were recognized here—the subalpine zone, which comprised about 400 square miles, and the yellow-pine zone, comprising about 250 square miles. The subalpine zone is here as worthless for timber as upon the Montana side, the only timber suitable for the sawmill being in the yellow-pine zone. The estimated stand of timber within this area is 450,000,000 feet B. M., of which far the greater part consists of yellow pine, with a considerable quantity of red fir and about 72,000,000 feet of cedar. This cedar is found in dense groves in the bottoms of canyons, where a partial damming of the stream has produced marshy conditions. The density of its growth may be understood by the statement that in the areas occupied by it its stand is, on an average, 40,000 feet B. M. to the acre.

Agricultural lands.—There are no agricultural lands within the region examined on the Idaho side, and on the Montana side such areas are of trifling extent. They are situated in the valleys of South Fork, Little South Fork, West Fork, and Little West Fork. Altogether they are estimated to comprise about 1,500 acres.

Grazing.—The hillsides of the upper portion of the Bitterroot Valley are utilized to some extent for grazing. No sheep are pastured there, only cattle and horses, and no appreciable damage appears to be done by this grazing.

Mining.—There is no mining within that part of the reserve examined, except in the southeastern portion. In the valley of the South Fork many claims have been taken up upon Slate, Overwhich, Hughes, and Coal creeks, and some mining is being done, but upon a limited scale.

Timber cutting.—The cutting of timber upon the reserve may be grouped under three heads: (1) The cutting by squatters to improve their holdings, (2) cutting by pretended squatters for the market, and (3) cutting under timber permits. The first of these is of little moment; the third is by far the greatest. Altogether there has been logged within the Montana portion of the reserve an area estimated at 6,500 acres. In some cases the timber has been entirely removed and in others it has been only partially done, the timber being floated down Bitterroot River to the mills.

There are several mills in the Bitterroot Valley, the largest and most important of which is that of the Bitterroot Development Company, which supplies lumber to the Anaconda mine and to the general market.

The merchantable timber in the Montana portion of the reserve is comparatively easy of access and can all be readily logged. At the present rate of cutting the standing timber will in a few years be exhausted.

Forest fires.—Fires upon the Montana side of the reserve have probably been as extensive as elsewhere in the West, but have done far less damage to the merchantable timber, owing to the fact that yellow pine and red fir offer greater resistance to fires than do trees of other species. Probably not more than 5 per cent of the forests of these species has been destroyed. Higher up, in the subalpine zone, however, fires have been more disastrous, and it is estimated that fully 80 per cent of the wooded portion of this zone has been visited by fires within the last twenty-five or thirty years. While the destruction of merchantable timber by these fires has been slight, their effect upon the stream flow has in all probability been serious. The streams flowing eastward from the Bitterroot Mountains into Bitterroot River have very short, straight courses and an extremely steep descent. The clearing of the forests from their headwaters can not fail to change their regimen in such wise as to produce disastrous floods at one time of the year and low water during the remainder, thus inflicting double injury upon the agricultural interests in the valley.

The above description of the forest conditions of the eastern portion of the Bitterroot Reserve is derived from a report made by Mr. Leiberg, who devoted the last half of the season to its examination.

PRIEST RIVER RESERVE.

Mr. Leiberg commenced work upon the Priest River Reserve July 1, and finished the examination of that reserve in August.

The reserve comprises the drainage basin of Priest Lake and River, together with certain small bodies of land in the southern part drained directly to Clarke Fork. It lies mainly in the State of Idaho, a small portion of its area being comprised in northeastern Washington. Its area in Idaho is estimated at 552,960 acres, and that in Washington at 92,160, a total of 645,120 acres, or a little over 1,000 square miles.

Topography.—It is mainly a mountainous region, the level tracts forming probably not more than 12 or 14 per cent of the whole. In elevation it ranges from 2,000 to 8,000 feet. The reserve is composed mainly of the opposing slopes of two mountain ranges, one upon each side of the valley which incloses Priest Lake and River, and the summits of which form the east and west limits of the reserve. These two ranges converge nearly to a point at the north boundary of the reserve. The east range is an extension northwestward of the Cabinet Range; the western will be called here Pend Oreille Range. Of the two the Cabinet Range is the higher, its summit having an average altitude of about 6,000 feet, with peaks rising to 8,000, and is extremely rugged. The Pend Oreille Range is much less rugged than its neighbor and is less elevated, rarely rising above 6,000 feet. Priest Lake, which occupies a portion of the valley between the two ranges, is composed of two parts. The upper portion is about 2 miles long and a mile wide. The lower portion is the main lake. It has a length of about 18 miles and is from one-half a mile to 5 miles in width. It is drained southward by Priest River to Clarke Fork.

Forests.—The Priest River Reserve is essentially a forest-covered region. There are but few tracts within its boundaries that do not now, or did not a few years ago, support a dense, magnificent forest. The only areas destitute of forests from natural causes are marshes and the rocky crests and slides in the mountains. These, together with the water surface of the lakes and streams, are estimated to aggregate about 50,000 acres, which is only 8 per cent of the entire area.

The forests of this reserve may be grouped, for descriptive purposes, in three zones, depending upon altitude, distinguished as (1) subalpine fir, (2) white pine, and (3) yellow pine. The first of these comprises the area lying above an altitude of about 4,800 feet. The trees found within it are almost exclusively the subalpine fir and the whitebark pine, mainly the former. Neither of these species is of importance to the lumberman, largely because of the inaccessibility of its habitat.

The white-pine zone is the predominant one. It is found mainly between altitudes of 2,400 and 4,800 feet above sea level, altitudes which comprise about four-fifths of the forested portion of the reserve. The chief species found in this portion of the reserve are Western white pine and tamarack, although there are several other species of commercial importance mingled with them, such as cedar, Engelmann spruce, western hemlock, and white fir. The heaviest growth occurs on the level areas bordering the principal streams and is most abundant in the western half of the reserve. This zone is far the most important of those above mentioned from a commercial standpoint, containing much the largest quantity of commercial timber and being generally easy of access.

The yellow-pine zone lies below that of the white-pine, but the line of demarcation is not always easy to establish, the two zones merging into each other by insensible degrees. The principal species within this zone are the yellow pine, red fir, and white fir, nearly three-fourths of the timber consisting of red fir. The first two of these species are of commercial value.

The amount of merchantable timber at present contained in the reserve is estimated at 4,833 million feet B. M., including that suitable for saw timber, railway ties, and telegraph poles. The amount available for each of these several purposes is estimated as follows:

	M feet B. M.
Saw timber	1,903,600
Railroad ties	2,720,000
Telegraph poles	210,000

The forests have suffered greatly from fires at various times in the past, as is indicated by the fact that the forest is of widely differing age in different parts. The reserve contains bodies of timber of all ages, ranging from 250 and 300 years down to young saplings of a few years of age only, and the ground under the young trees is thickly strewn with fallen logs, charred and partially rotten, the remains of the fires.

It is estimated that if the reserve had remained untouched by recent fires it would contain at present 16,250 million feet B. M. of timber, instead of less than 5,000 million, which it contains at present. More than 11,000 million feet of timber has been destroyed by fire within the last thirty-five years, without benefiting anyone.

Cutting.—But little cutting has been done upon the reserve. Most of that consisted of tie timber and piling used in the construction of the Great Northern Railway. Last summer parties were cutting western white pine in small quantities and shipping it out. Aside from this the only consumption of timber upon the reserve has been by settlers for their improvements and for fuel.

The only means available at the present time for transporting lumber out of the reserve is by driving down Priest River to the Great Northern Railway.

Arable lands.—The arable lands are found entirely in the Clarke Fork Valley and in that of Priest Lake and River, the whole aggregating about 10,000 acres. They consist of high ground covered with sedges or grass, marshes which can be reclaimed, grass land subject to overflow, and cleared land on the benches adjacent to streams. The bulk of them are situated on the western side of the valley of Priest Lake and River, where the rock formation is softer and the valleys are consequently broader and more level. The greater portion of these tracts is held by settlers.

Many squatters' claims have been located in the white-pine forest, ostensibly for agricultural purposes, but less than 5 acres have been cleared altogether from the living white-pine forest.

Mineral claims.—Many claims have been located within the reserve, but none have been as yet sufficiently developed to show profitable deposits.

WASHINGTON RESERVE.

This being much the largest of all the areas to be examined, and by far the most important from an economic standpoint, much fuller provision was made for its examination than in the case of the other reserves. For the examination of the portion of this reserve lying east of the divide of the Cascade Range, Messrs. W. G. Steel and M. W. Gorman were employed. They commenced work about the middle of August and completed it in the latter part of November. For the western portion Mr. H. B. Ayres was employed, and to its examination he devoted four and a half months—from the middle of July to the end of November.

Topography.—This reserve is composed almost entirely of high mountain ranges intersected by deep valleys. It is traversed by the crest of the Cascade Range, which, entering the reserve from British Columbia, near longitude 120° 45′, trends in a generally southwesterly direction across the reserve, although making several great turns to the south and west in its course. This crest and the mountains in its neighborhood are extremely rugged, rising to altitudes exceeding 10,000 feet, and contain many glaciers. Eastward and westward from the crest the mountains diminish in altitude.

West of the divide the reserve is drained westward to Puget Sound, mainly by Skagit and Stilaguamish rivers and their branches. East of the divide the Methow and Stehekin rivers drain it to Columbia River.

The rainfall is heavy upon the western slope of the range. Upon the eastern side it is decidedly less, so that irrigation is commonly required for the production of crops. The streams are numerous and bold. The rainfall is, however, less than it has been in past time, as is evidenced by the fact that every canyon and gorge leading out of the mountains has been until recently the bed of a glacier, whose remains still exist, occupying the mountain valleys.

Forests.—Almost the entire area of the reserve is naturally a forested region, with the exception of a few small tracts, which are above timber line, or which are composed of rocky mountain slopes, upon which there is not sufficient soil for trees to obtain footing, and with the exception of the valley of Methow River in the east. The natural forest growth differs greatly in density in different parts. It is densest in the lower valleys on the west side, and diminishes in density as the summit of the range is approached. The east side of the mountains is much less densely forested than the west side, and the forests diminish as the elevation becomes less upon the east side. This arrangement of the forests has, however, been interfered with greatly by fires, which have denuded large areas entirely and have reduced the density in other places. The results of these fires have been more disastrous on the east side than on the west, owing to its generally drier conditions.

The commonest tree upon the reserve is the western hemlock (*Tsuga mertensiana*). Far the greater part of the timber on the reserve consists of this species.

Another common tree is the Sitka spruce (*Picea sitchensis*), which is found along streams up to an altitude of 2,000 feet.

Red fir (*Pseudotsuga taxifolia*) is found in the bench lands of the valleys and the lower mountain slopes.

Cedar (*Thuja plicata*) is found mixed with red fir and hemlock in the bottom lands and on mountain tops.

Mountain cedar (*Chamæcyparis nootkatensis*) is found on mountain slopes above 2,000 feet.

Engelmann spruce (*Picea engelmanni*) is found at high altitudes, and is small and difficult of access.

White fir (*Abies grandis*) is found on moist land and northern slopes up to 5,000 feet.

Abies amabilis is found on moist land and northern slopes up to 4,000 feet.

Alpine fir (*Abies lasiocarpa*) is found on the higher slopes and summits.

White pine (*Pinus monticola*) is found sparingly at medium altitudes on bench lands and lower mountain slopes.

Yellow pine (*Pinus ponderosa*) is found in the drier parts of the upper Skagit Valley and generally in the lower portions of the eastern part of the reserve.

The lodgepole pine (*Pinus murrayana*) is found sparingly in dry bench lands and generally in the drier eastern portions of the reserve.

White-bark pine (*Pinus albicaulis*) is sparsely distributed at high altitudes.

Alpine larch (*Larix lyellii*) is not uncommon along the summit of the Cascade Range from Cascade Pass northward.

The principal among these species for lumber purposes are the hemlock, spruce, red fir, cedar, and yellow pine.

The total amount of standing timber upon this reserve is estimated to be not far from 20,000 million feet B. M., two-thirds of which is hemlock, the remainder being distributed among the other species.

Agricultural land.—The tracts of land within the limits of the reserve which are suitable for agriculture are numerous but individually small in area. On the west side of the divide, where the rainfall is abundant and irrigation is not necessary for the cultivation of crops, all the flat valley land not at too great elevation is of value for this purpose. Such lands are as follows:

A strip along each fork of the Stilaguamish 3 miles in breadth.

The valley of Sauk River below the south fork of the north fork, 3 miles in width.

In the valley of Suiattle River for a distance of 12 miles within the reserve, with an average breadth of 1 mile.

The valley of Cascade River for a distance of 6 miles within the west boundary of the reserve, by half a mile in width.

The valley of Skagit River, from Ruby Creek to Goodells, with an average breadth of 2 miles.

The valley of Baker River, from Baker Lake to the boundary of the reserve, with an average breadth of 4 miles, and above Baker Lake, with a breadth of 1 mile.

The valley of North Fork of Nooksack River, below Ruby Creek, with a width of 1 mile.

The total area of these tracts is estimated at 230 square miles. Upon the east side of the divide the agricultural lands generally require irrigation, and are therefore limited, not only by their location and surface, but by the amount of water available. They are as follows: A few tracts in the Methow Valley and along Twisp River, a few trifling patches on the shores of Lake Chelan, and a narrow strip in the valley of Stehekin River. Altogether, the area of the arable land in this part of the reserve is trifling, and has already been filed upon or is held by squatters.

Grazing.—There is very little pasturing of stock within the reserve, and none whatever of sheep. The western portion of the reserve affords but little pasturage, owing to the density of the forest. The eastern portion, on the other hand, affords much excellent summer grazing in the high mountain valleys and slopes, but it is little utilized as yet.

Means of communication.—These are extremely scanty. The Everett and Monte Cristo Railway, which connected the mines at Monte Cristo with Everett, upon Puget Sound, some 60 miles, ran for half its distance within the lines of the reserve. This, however, has been completely washed out recently, and is, it is understood, not to be rebuilt. There are wagon roads from Barlow Pass to Goat Lake, from the mouth of White Chuck River down Sauk River, and along Cascade River, all on the west side of the reserve. These form about 30 miles of wagon roads within the reserve on this side. Upon the east side there is a road for a short distance up the valley of Methow River.

There are numerous trails, passable for pack horses, connecting different portions of the reserve. The principal one of these, which connects the valley of Methow River with Marblemount, at the junction of Cascade and Skagit rivers, by way of the Twisp, Bridge Creek, Stehekin River, and Cascade Pass, is now being improved at the expense of the State, and may be developed into a wagon road.

Mining.—There is considerable mining, consisting mainly of development work, going on within the reserve. At Monte Cristo and Silverton are developed producing mines, which were worked actively until the recent destruction by flood of the Everett and Monte Cristo Railway. These two mining camps contained several hundred inhabitants each. The destruction of the road has, however, caused a cessation of activity. Mineral discoveries have been made at other points along this road and in its neighborhood.

Many discoveries have been made in the Ruby Creek mining district, on the upper waters of Skagit River, in the Methow district, on the upper waters of the Methow, and in the mountains west of the upper end of Lake Chelan, but, owing to lack of transportation, little has been done beyond development work.

Settlements.—Upon the west side, the mining towns of Monte Cristo and Silverton have already been mentioned. Besides these there is some little settlement in the valley of the Stilaguamish below Silverton. Upon the Sauk, within the reserve, there are a few ranches. Upon Cascade River are three or four ranches, and there is some settlement in the Ruby Creek district depending upon the mines. Upon the east side there are a number of ranches in the Methow Valley, including the little town of Winthrop and the mining village of Camp Gilbert. Upon Lake Chelan there are a few ranches and the hotel at the head of the lake. A few miners are located upon Railroad and Company creeks, west of the upper portion of the lake.

Timber cutting.—There is no timber cutting within the reserve, except a trifling amount for the local needs of the settlers and mines. There is at present very little demand for its timber, the general market being supplied by the forests farther west.

The facilities for getting timber out of the reserve are very poor. With the exception of the trifling amount of wagon roads, the only routes would be by the streams, and these are extremely rapid and rocky. Much work would be required upon them to make them suitable for driving logs.

SAN JACINTO RESERVE.

The three reserves in southern California—San Jacinto, San Bernardino, and San Gabriel—were examined by Mr. J. B. Leiberg in the spring of 1898, and his preliminary report upon them forms part of the present volume. The fuller and more complete report upon these reserves will be published later.

The San Jacinto Forest Reserve comprises about 740,000 acres, or about 1,160 square miles. It is a mountainous and broken country, comprising the San Jacinto and Toro ranges and the Toro and Coahuila mesas. The rock formation is granite or allied rocks.

The elevation ranges from 3,000 to 10,000 feet. The lower portion—up to an altitude of about 5,000 feet—is arid and is covered with a dense growth of chaparral. Above 5,000 feet the country is wooded, the timber consisting almost entirely of yellow pine, with a little sugar pine and Coulter's pine and other species scattered sparsely through it. Of the entire area of the reserve 141,000 acres only are timbered, and upon this land there is, it is estimated, timber to the amount of 91,110,000 feet B. M. Of its area only 2,000 acres are under cultivation, and to a small extent only is it used for pasturage.

There has been considerable timber cutting in the reserve, but at present there are only two small mills operating there. As the region lies within the land grant of the Southern Pacific Railroad Company, one-half of the area, consisting of alternate sections, belongs to that corporation.

SAN BERNARDINO RESERVE.

This reserve comprises an area of 737,000 acres. It consists wholly of the San Bernardino Range, a somewhat complex mass with a northwest-southeast trend. The altitude ranges from 3,000 to 11,600 feet upon the highest summit of the range. The rock formation is almost entirely granite. As in the San Jacinto Reserve, the lower portion of this reserve is covered with dense chaparral, running up to an altitude of about 5,000 feet. The lands above the latter elevation are covered with open forests, consisting almost exclusively of yellow pine. These timbered areas comprise, it is estimated, 246,000 acres, or about one-third the area of the reserve. Besides this there is an area of 64,000 acres upon the north side of the range, within the reserve, covered with piñon pine and juniper, which is of no value for lumber purposes, but is serviceable for firewood. The estimated amount of merchantable timber upon the reserve is 479,440,000 feet B. M.

The cultivated tracts upon the reserve amount, in the aggregate, to only 1,200 acres.

The reserve is but little used for pasturage purposes, although the pasturage is excellent in the pine forests.

SAN GABRIEL RESERVE.

This reserve comprises the Sierra Madre of southern California, an extension to the northwestward of the San Bernardino Range. The area of the reserve is 550,000 acres, but about 650,000 acres were examined. The region ranges in altitude from 1,000 to 10,000 feet—the summit of the highest peak, "Old Baldy." Up to an altitude of 5,000 feet, as in the other reserves, it is covered with chaparral, while above this elevation the high mountain valleys and the mountains themselves are covered with an open forest, consisting largely of yellow pine. The timbered areas comprise about 100,000 acres, and the amount of merchantable timber within the reserve is estimated at 60,000,000 feet B. M. All of it is of inferior quality, being short and knotty, and a great part of it is, at present at least, inaccessible. There is little cultivated land within the reserve.

BLACK HILLS FOREST RESERVE.

(South Dakota and Wyoming.)

By Henry S. Graves.

LIMITS OF RESERVE.

The following are the limits, as described in the Executive order of February 22, 1896:

Beginning at the southeast corner of township five (5) south, range five (5) east, Black Hills meridian, South Dakota; thence northerly to the northeast corner of said township; thence easterly to the southeast corner of section thirty-three (33), township four (4) south, range six (6) east; thence northerly to the southeast corner of section nine (9), said township; thence easterly to the southeast corner of section twelve (12), said township; thence northerly along the range line to the northeast corner of section thirteen (13), township one (1) north, range six (6) east; thence westerly to the northwest corner of said section; thence northerly to the northeast corner of section two (2), said township; thence westerly to the northwest corner of said section; thence northerly to the northeast corner of section twenty-two (22), township two (2) north, range six (6) east; thence westerly to the southeast corner of section seventeen (17), said township; thence northerly to the northeast corner of said section; thence westerly to the northwest corner of said section; thence northerly to the southeast corner of section thirty (30), township three (3) north, range six (6) east; thence easterly to the southeast corner of section twenty-seven (27), said township; thence northerly to the northeast corner of section twenty-two (22), said township; thence westerly to the northwest corner of said section; thence northerly to the northeast corner of section sixteen (16), said township; thence westerly to the northwest corner of said section; thence northerly to the northeast corner of section eight (8), said township; thence westerly to the northwest corner of said section; thence northerly to the northeast corner of section nineteen (19), township four (4) north, range six (6) east; thence westerly to the northwest corner of said section; thence northerly to the northeast corner of section twelve (12), township four (4) north, range five (5) east; thence westerly to the northwest corner of said section; thence northerly to the northeast corner of section thirty-five (35), township five (5) north, range five (5) east; thence westerly to the northwest corner of said section; thence northerly to the northeast corner of section twenty-seven (27), said township; thence westerly to the northwest corner of said section; thence northerly to the northeast corner of section twenty-one (21), said township; thence westerly to the southeast corner of section thirteen (13), township five (5) north, range four (4) east; thence northerly to the northeast corner of said section; thence westerly to the northwest corner of said section; thence northerly to the northeast corner of section two (2), said township; thence westerly to the northwest corner of section four (4), said township; thence southerly to the southwest corner of said section; thence westerly to the southeast corner of section two (2), township five (5) north, range three (3) east; thence northerly to the northeast corner of said section;

thence westerly to the southeast corner of section thirty-five (35), township six (6) north, range two (2) east; thence northerly to the northeast corner of section twenty-six (26), said township; thence westerly to the southeast corner of section twenty-four (24), township six (6) north, range one (1) east; thence northerly to the north-east corner of said section; thence westerly along the section line to its intersection with the boundary line between the States of South Dakota and Wyoming; thence southerly along said State boundary line to its intersection with the section line between sections twenty-eight (28) and thirty-three (33), township fifty-two (52) north, range sixty (60) west, sixth (6th) principal meridian, Wyoming; thence westerly to the northwest corner of section thirty-six (36), township fifty-two (52) north, range sixty-one (61) west; thence southerly along the section line to its intersection with the twelfth (12th) standard parallel north; thence easterly along said parallel to its intersection with the boundary line between the States of Wyoming and South Dakota; thence southerly along said State boundary line to its intersection with the section line between sections eighteen (18) and nineteen (19), township three (3) south, range one (1) east, Black Hills meridian, South Dakota; thence easterly to the northwest corner of section twenty-two (22), said township; thence southerly to the southwest corner of section thirty-four (34), said township; thence easterly to the southeast corner of said township; thence southerly to the southwest corner of section thirty (30), township four (4) south, range two (2) east; thence easterly to the southeast corner of section twenty-seven (27), said township; thence southerly to the southwest corner of section eleven (11), township five (5) south, range two (2) east; thence easterly to the northwest corner of section eighteen (18), township five (5) south, range four (4) east; thence southerly to the southwest corner of said township; thence easterly to the southeast corner of township five (5) south, range five (5) east, the place of beginning; excepting and excluding from reservation all those certain tracts, pieces, or parcels of land lying and being situate within the boundaries particularly described as follows, to wit:

Beginning at the northeast corner of section twenty-four (24), township five (5) north, range three (3) east, Black Hills meridian; thence westerly to the northwest corner of section nineteen (19), said township; thence southerly to the northwest corner of section thirty-one (31), said township; thence westerly to the northwest corner of section thirty-six (36), township five (5) north, range two (2) east; thence southerly to the southwest corner of section thirteen (13), township four (4) north, range two (2) east; thence easterly to the southeast corner of section fifteen (15), township four (4) north, range three (3) east; thence northerly to the southwest corner of section two (2), said township; thence easterly to the southeast corner of said section; thence northerly to the northeast corner of said section; thence easterly to the southeast corner of township five (5) north, range three (3) east; thence northerly to the northeast corner of section twenty-four (24), said township, the place of beginning.

TOPOGRAPHY.

Geographically, the Black Hills are situated between the Belle Fourche and the South Fork of the Cheyenne River, between the forty-third and forty-fifth parallels of latitude and the one hundred and third and one hundred and fifth meridians. They are on the line between Wyoming and South Dakota, but the greater portion lies in the latter State. The Black Hills constitute an isolated range of mountains with a general north-south trend, and are about 120 miles long and 40 miles wide.

Almost entirely encircling the main body of mountains and separated from them by a broad valley, called the "Race Track," there is an outlying rim of ridges varying in elevation from 200 to about 800 feet above the plains. The mean altitude of the plains is about 3,000 to 3,500 feet, and the average elevation of the hills above them is about 2,000 feet. The highest point is Harney Peak, which has an absolute altitude of 7,215 feet above sea level. This peak is in the eastern section of the hills and is in the center of the most mountainous, rugged portion of the entire range. The Harney Peak Range is made up of a multitude of precipitous broken ridges radiating out from Harney Peak and towering 500 to 1,000 feet above the canyons and valleys. The form of the mountains is due to the erosion of the soft schists, leaving the hard granite standing out as broken serrated ridges and walls.

The main backbone of the Black Hills is the high plateau of Carboniferous limestone which runs north and south near the line between South Dakota and Wyoming. This divide forms the watershed of all the important streams in the hills. It is a broad, nearly level plateau, about 7,000 feet above the sea, broken by numerous depressions, which are for the most part open and covered with a luxuriant growth of grass. These swales run into the deeper ravines at the head of the various creeks. In the torrential portion of the streams deep canyons have been cut through the limestone into the underlying sandstone. Wherever the schists and soft slates predominate the country is comparatively level, the valleys are broad, and the hills are low and rounded. Where the hard slates occur the country is broken into high ridges and peaks, with deep ravines and canyons between them. With the exception of Harney Peak and Crook Tower the most prominent points are composed of igneous rock. The belt of limestone on the eastern edge of the range is characterized by high plateaus and flat ridges, separated by deep canyons. Detailed topographical descriptions are given with the discussion of the various forest districts at the end of the report.

The Black Hills give rise to no important river, but without doubt have a large influence on the drainage of the Belle Fourche and Cheyenne rivers. The hills are well watered and there are a large number of streams within the timbered portion, but the majority of them sink before or soon after reaching the plains. The important streams on the eastern side of the mountains are Rapid, Spring, Battle, and Beaver creeks; in the northern section Bear Butte, Whitewood, and Spearfish creeks; and on the western side Sand and Stockade Beaver creeks. These, as well as the smaller streams, are discussed individually under the detailed forest descriptions.

Within the hills there is but little irrigation. The land which has been taken up for farming lies along the streams, and the soil is sufficiently fresh to produce abundant crops without irrigation. At the edge of the hills the water is used to a considerable extent on Spearfish, Stockade Beaver, and Sand creeks. The mines at Lead and Deadwood obtain their water from Whitewood Creek; those at Keystone, from Battle Creek. Little Rapid is turned at Rochford and Gregory;

Castle Creek at Lookout and below Mystic; Spring Creek at Sheridan; and on nearly all streams the water is flumed for smaller operations. On Squaw Creek there is a small sawmill run by water power.

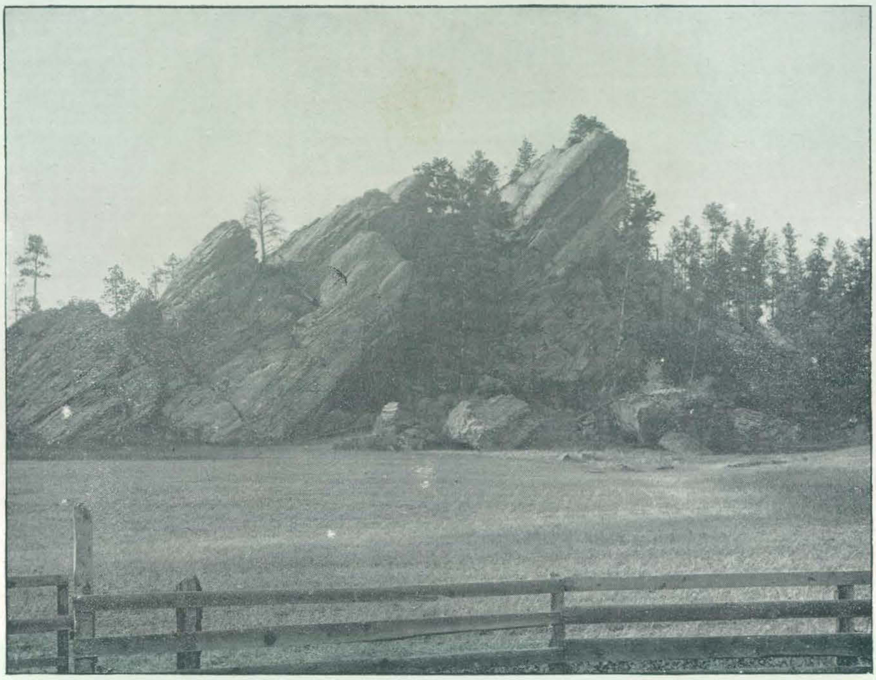
AGRICULTURAL LAND.

Within the timbered portion of the Black Hills there are no very extensive bodies of agricultural land. Along most of the streams, especially on the formation of micaceous schist and soft slate, where the country is comparatively level and rolling, there are strips of rich land suitable for farming purposes. At the head of Elk and Box Elder creeks, on the upper part of Slate, central portions of Spring and French creeks, and upper part of Beaver, Cold Brook, and Red Canyon creeks are the most extensive bodies of tillable land which have been taken up. In these sections the hills are low and rounded, and the valleys comparatively broad and for the most part open and covered with a thick growth of grass. The soil is a rich earthy loam and is very productive.

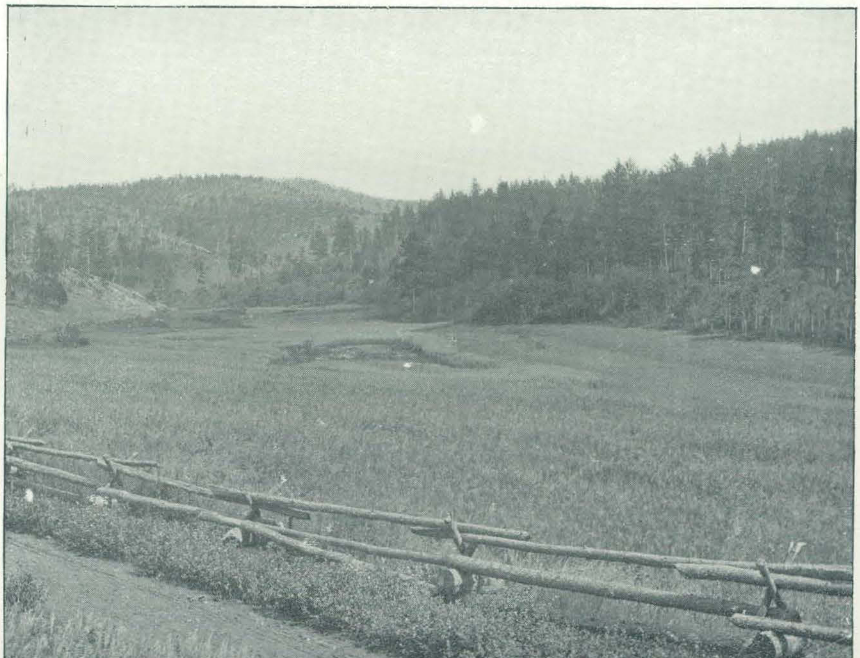
In the limestone section there are a great number of open parks following the shallow ravines at the headwaters of the various streams, which are being taken up for farming purposes. The soil is a strong, rather compact calcareous clay, and will produce anything which the climate will permit. A large part of such land, however, is at high elevations, and the seasons are so short that ranching does not pay. The heavy snow and extreme cold of winter make it necessary to feed the stock, and the season of vegetation is so short that grain will not ripen. In many parts of the limestone region the lack of water renders farming impossible. In the hard slate formations the valleys are usually so covered with trees or brush that but little attempt has been made to clear them for agricultural purposes. Further, in the narrow ravines and canyons the danger from frost is often considerable.

In Cold Springs Canyon and its tributaries in Wyoming, there is a large amount of rich land in long, narrow strips which is being taken up by ranchers. There are still considerable areas of cultivable land in the Limestone Range which have not been located; and at the head of Box Elder, Spring, French, and other creeks, there are to be found level tracts covered with forests, which, when cleared, will make admirable farming land.

The ranches are taken up as placer claims in 20-acre plats, and in this way long strips of cultivable land are obtained along the open valleys. Probably there are not, on an average, more than 30 to 40 acres of plowed land on each ranch, the rest of the open area being used for hay or pasture. There are altogether 450 to 460 ranches in the timbered portion of the Black Hills. In the foothills, below the timber line, there are a great number of ranches scattered along the streams and on rich flats.



A. SCHIST OUTCROPPING NEAR CUSTER, SOUTH DAKOTA.



B. AN OPEN PARK 2 MILES NORTHWEST OF ROCHFORD, SOUTH DAKOTA.

The chief products are oats, hay, and vegetables. At low elevations, near the edge of timber, corn is raised to some extent, and in Wyoming, on the high plateaus, wheat forms the main crop. Timothy is cultivated to some extent in the mountains, and several ranchers control large tracts of park land in the Limestone Range and cut the native hay for the market. Where the land is irrigated, alfalfa is raised in considerable quantities. There is a ready market for agricultural products.

GRAZING LAND.

Throughout the hills there is a large amount of open land, especially along the bottoms of the broad valleys, which is covered with a rich growth of grass and makes excellent pasture for stock. The largest amount of grazing land within the timber limits is on the open parks and prairies of the southern hills. In the central portion there is a large amount of stock owned by ranchers, which ranges through the forest, and on Reynolds, Slate Creek, and Bald Hills prairies there are pastured probably about 1,000 head of stock. The country is so mountainous and rugged in the northern hills that there is comparatively little stock raising, and in the Limestone Range, although there is a thick growth of grass through the forest, the climate is so rigorous that the country is unsuitable for a winter range. It is estimated that there are about 5,000 head of stock ranging within the timbered portion of the hills, including the small bunches of cattle and horses owned by the ranchers. There are no sheep pastured within the hills. No harm is done to the forest by the stock.

MINING.

This is the most important industry in the Black Hills, and in the northern portion probably not less than two-thirds of the population are engaged in connection with the mines. The principal mining center is at Lead and Deadwood, where the Homestake mine is located. There are a number of small towns in the vicinity supported by the mines, about which they have been built, notably Gayville, Pluma, Terraville, Central, Springtown, Garden, Ragged Top, and Galena, and throughout this region mining camps are scattered, where men are busy prospecting and developing claims. On Little Rapid, Castle, Rapid, and Spring creeks mining is one of the chief industries, though not prosecuted on so extensive a scale as in the northern hills. The most important mineral belt in the central hills is at Keystone, where the Holy Terror and Keystone mines employ a large number of men. Throughout the eastern portion of the Black Hills there are scattered small mines and discovery pits, said to be valuable, but on which no operations are carried on except the annual developing work required by law to hold the claims. In the forest descriptions note is made of the extent of this industry in each region.

THE FOREST.

DISTRIBUTION.

The exterior outlines of the main body of forest in the Black Hills are for the most part sharply drawn. In general, the forest terminates abruptly at the "Race Track," or broad valley lying between the main portion of the hills and the line of ridges which entirely encircles them. In certain cases these outlying ridges become more than mere low foothills and are clothed with forest. Thus, the Elk Mountain Range, Pisgah Hills, Inyankara Range, and Bear Lodge Mountains are covered with timber, while the low ridges in the northeastern portion are either bare or have merely a narrow fringe of trees on the summits. The northeastern boundary of the timber follows closely the foot of the hills from the mouth of Spearfish Canyon to the point where Bear Butte Canyon widens out; thence it swings southeast, skirting the valley through which the Fremont, Elkhorn and Missouri Valley Railroad now runs, to Canyon Lake; south of this point the outline of timber is more irregular and has probably been pushed back within the hills from the original limit by forest fires. In general, the boundary line runs nearly south from Canyon Lake to the mouth of French Creek Canyon, and thence nearly southwest to about 2 miles below the point where the south fork of Beaver Creek bends to the southeast. The southern boundary of the timber forms an irregular line, skirting along the foot of the more rugged ridges from the point on Beaver just mentioned, across the heads of Pass Creek, Hell, and Tepee canyons, to the mouth of Gillette Canyon. The timber follows the canyon and side ravines of Cold Brook to Hot Springs and the slopes of Red Canyon. The ridge on the north side of Pass Creek is covered with an open forest from near Red Canyon to Elk Mountain. The western boundary of the forest runs nearly north from the mouth of Gillette to the head of Soldier Creek, and follows the latter to the Black Buttes. From this point the Grand Canyon forms the western limit of timber, and from its mouth the boundary runs east to the mouth of Spearfish Canyon.

The Black Hills are, in the main, densely timbered, but the forest is broken in many places by parks and mountain prairies, and enormous tracts have been entirely denuded by forest fires. The entire area within the exterior boundaries of the timber is about 2,600 square miles. Of this, about 2,000 square miles are now covered with forest. The rest is either open parks and prairies or covered with a scattered growth of young timber. There are, in addition, small areas covered with forest on the Elk Mountain Range, Pisgah Hills, Inyankara, and Bear Lodge Mountains.

COMPOSITION AND FORM.

The yellow pine (*Pinus ponderosa* Laws) is the only tree in the Black Hills of commercial importance. The other species are so small, occur in so limited numbers, or else have so few uses, that they are of silvicultural and botanical interest rather than of economic importance. By far the greater portion of the hills is covered with a pure forest of pine. On every formation, at all elevations, in all situations, both in ravines and on high ridges and slopes, the yellow pine is found, either alone or far outnumbering other species. With the exception of some northern slopes in the high Limestone Divide and on Harney Peak, where small bodies of spruce occur, and some burnt tracts, where aspen has come up in large quantities, the other species are found only in small patches or as scattered individuals.

The important species associated with the pine are as follows:

Spruce (*Picea canadensis* Mill) B. S. P.
Aspen (*Populus tremuloides* Mx.).
White birch (*Betula papyrifera* Marsh).
Bur oak (*Quercus macrocarpa* Mx.).
Box elder (*Acer negundo* L.).
White elm (*Ulmus americana* L.).
Ironwood (*Ostrya virginiana* Mill) Koch.
Cottonwood (*Populus deltoides* Marsh).
Cottonwood (*P. angustifolia* James).
Red cedar (*Juniperus virginiana* L.).

The other species, which are very small, will be enumerated below.

The forest as it appears to-day, irregular and broken, and composed in many places of defective and scrubby trees, does not represent what the yellow pine is capable of producing. There are trees of every age and size, and there are large areas where there are no trees at all. For a pure forest the yield in merchantable timber is exceedingly small. Forest fires are directly responsible for the present condition, which is the result of long abuse and the struggle of the forest to reestablish itself in its original form. The cause of the broken condition of the forest, of the large proportion of defective trees, of the many windbreaks, of the mountain prairies, parks, and bald ridges, has been the destructive forest fires which have swept the Black Hills periodically for years and probably for centuries. The natural forest of yellow pine is dense and composed of trees of about the same age. It often comes up in even-aged stands, and the irregular uneven-aged condition as now found is entirely due to external influences. The original forest, uninfluenced by fires or windfalls, is found in but few places in the Black Hills. In order to present more clearly a picture of such a forest, the following sample plat is given:

Condition of one-half acre of original forest in Rifle Pit Gulch, Wyoming.

Diameter (inches).	Clear trees.	Scrubby trees.	Dead trees.
10	4	....	....
12	5	4	1
14	2	2	....
16	10	....	....
18	12	1	....
20	5	....	....
22	3	....	....
Total	41	7	1

Board feet	6,700	Slope	15° NW.
Cords, including tops	13	Soil, fresh and rich.	
Density	.8	Average height	85 feet.

It is interesting to compare this forest with one in which fires have occurred at different periods, growing on equally good soil, and considered by settlers a fine body of timber:

Condition of one-half acre of forest subject to forest fire near Gillette's ranch at the head of Slate Creek, South Dakota.

Diameter (inches).	Clear trees.	Scrubby trees.
6	1	1
8	2	
10	1	6
12		3
14	1	5
16	3	1
18	3	6
20	4	5
22	1	
24		1
Total	16	28

Board feet	2,600	Slope	10° E.
Cords, including tops	14.5	Soil, fresh and rich.	
Density	.5	Average height	75 feet.

Taking the forest as a whole, it is composed of trees of nearly every age class. The original growth is broken by patches of younger trees varying in extent from a few to several hundred acres. The old timber has an age of 250 to 300 years. It is found chiefly along streams, in ravines and canyons, at the heads of creeks and side draws, and on protected flats and lower slopes.

There are three classes of old trees which differ in development and character. The first class is found on rich soil and in protected situations. The trees average about 20 inches in diameter and have a maximum size of 3 feet. This timber reaches a height of 100 feet, but the average is not over 80 feet, and the stems are straight and clear of limbs for 30 to 50 feet. Such timber has grown in crowded stands. Forest of this character is found, in places, on the divide west of Spearfish Canyon, on South Box Elder, at the head of Spring Creek, on Soldier, Cold Springs, and Sand creeks, and elsewhere in small amounts. It has an average yield of 4,000 to 8,000 board feet per acre.

The second class of original timber is that which covers the greater portion of the Black Hills. It has about the same development in diameter, but is not so tall as the first class. It averages about 65 to 70

A. FOREST ABOVE SQUAW CREEK, IN WHICH THE TREES HAVE GROWN TOO FAR APART TO MAKE CLEAR TIMBER.

B. CROSS SECTION OF A TREE IN WHICH AN INJURY BY FIRE HAS BEEN COMPLETELY HEALED OVER, LEAVING A SPOT OF DECAY IN THE CENTER.

feet in height, and has a clear length of 25 to 40 feet. The forest has not grown so dense as that above described. This kind of forest is found in situations more exposed to external dangers and has been more subject to injury by forest fires than the first class. The forest about Custer and Hill City represents this class of timber.

The third class of timber is found on ridges and steep slopes, and is both smaller and shorter than the first two classes. The average diameter is about 14 to 17 inches and the height is not over 60 feet.

The development of the pine depends primarily on the situation and the soil. The old timber in canyon bottoms and side ravines is of superior development and quality, not only because the soil is rich and fresh, but because the trees are in protected situations. Much of the soil on which trees of the second class, above described, are growing is very fertile and could produce forests of the first class if established sufficiently dense and protected from fire. On steep slopes and ridges the soil is stony and thin and the trees are consequently shorter and smaller. As a rule, the forests on the north slopes are denser and of better quality than those on the south slopes, not only because of the greater amount of moisture, but chiefly because they are less injured by fire. The geological formation affects the development of the forest through the influence on the configuration of the country and by the character of the soil formed. The difference between the forest in the Carboniferous limestone and that in the Archean is due chiefly to the fact that on the great level plateaus of the former the forest has been more exposed to fires than in the more broken country of the Archean formations. In equally protected situations the difference in development of the pine is not apparent. The soil has an influence more through its physical than its chemical properties. In general, however, limestone soils are stronger than other soils, and the trees naturally grow more vigorously, and, unless the forest is very dense, clothe themselves with persistent branches. The difference in soil has also an effect on reproduction, which is discussed in another chapter. For the best development of pine the soil should be deep, fresh, porous, and have a fair admixture of vegetable humus. Just such soil is found in the Dakota sandstone formation in Wyoming on Cold Springs Creek.

The second factor in the development of pine forests is the degree of density with which it was established. To produce timber of good quality the forest must be sufficiently dense to prune the trees of the lower branches. Under heavy shade these branches will die and fall off and the scars heal over. In open forests the branches remain on the trees and the timber is coarse and knotty. This is readily seen by comparing the illustrations on Pls. XX (*A*) and XXVI. Trees prune themselves better on poor than on active soils.

There are a large number of defective trees in the old forest. Many of these are hollow; others show an exudation of resin from branch wounds; on others the limbs within the crown, with dry moss clinging to them, or the dry tops, are signs of internal decay. In some places as many as 50 per cent of the trees are defective. The largest trees are often rotten at the butt, as, for example, in the Red Bird Creek region and on Rapid and Squaw creeks. The cause of so much defective timber is chiefly the repeated burning to which the forest has been subjected. The average amount of dead timber is estimated at 3 to 4 per cent throughout the original forest.

Not only is there a large amount of young growth scattered throughout the original forest, but there is a great belt in the northern hills composed almost entirely of second-growth timber. By second-growth timber is meant thrifty growing trees not yet large enough for lumber. This belt of timber extends, or did extend before white men came into the hills, from a line running from the mouth of Bear Butte Canyon to a point near Greenwood, west to Spearfish Canyon, and thence south through the Limestone Range to the headwaters of Hell and Gillette canyons. This forest is composed of poles 10 to 14 inches in diameter on the stump, and is about 100 years old. A large body of it in the northeastern section has been either burned or cut off, but the greatest portion still remains. Some old timber is scattered through the forest.

In many places the second growth is very dense, with as many as 150 to 200 trees per acre. Comparing the forest to one in which the forest floor is entirely under shade and may be said to have a density of 1.0, the second-growth forest is estimated to have an average density of 0.7 within the timber limits. The original forest has an average density of 0.5.

Throughout both the second-growth and the original forest there are scattered trees about 150 to 160 years old, which are just coming to merchantable size. In the northern hills there are a considerable number of young poles about 50 years old, and in the southern hills the young growth is mostly about 40 years old. In general there are approximately 300 square miles covered with second growth, not counting what is scattered through the old timber.

At very high elevations in the northern part of the Limestone Range there are some considerable bodies of spruce, and on northern slopes this tree occurs locally almost pure. A conspicuous example of this is near the head of main Castle Creek, where the north slopes are clothed with spruce and the southern exposures have a second growth of pine. On Harney Peak spruce is found on the slopes and ridges. At lower elevations it occurs in deep, cool, moist canyons and follows the creeks. Its distribution is in general in the northeastern section of the hills, above an elevation of about 4,500 feet. As a rule, spruce ends where oak begins, although they are found together in a few localities. The former is found as far south as French Creek, but not on the western slope of the Black Hills, except near the summit of the divide. Spruce demands a large amount of moisture in the atmosphere and requires a cool climate. While it grows in the rich canyon bottoms, it is also found on Harney Peak on the most meager, primitive soil, showing that moisture in the soil is not a requisite provided the air is moist and cool.

Spruce attains a diameter of nearly 3 feet and a height of about 100 feet. The average size is only about 12 to 18 inches, and the height not over 70 to 80 feet. At the lower elevations it is even smaller. The tree has a quick taper, and is almost always thickly covered with long, persistent branches reaching nearly to the ground, which make the timber useless for saw lumber. The trees grow in thick patches, and sometimes a few specimens may be selected with fairly long clear boles. Such trees are, however, usually too small for lumber. In the northern hills, where easily accessible, it is used for mine props. Elsewhere it is used locally for fuel and building timbers. The Indians use the small trees for lodge poles. Within its restricted limits it reproduces itself prolifically, and the young growth is capable of enduring dense shade from above. It is extremely sensitive to fire, and is killed outright where pine is but little injured. It is estimated that about 15,000 acres are covered with spruce.

Aspen, though of little value commercially, is of great interest to the forester. It is very abundant throughout the hills in ravines and canyons, on north slopes and shallow depressions, and, where the soil is sufficiently fresh, on ridges. It is the first tree to return after fires in the situations described. The presence of a thick layer of litter on the ground hinders the germination of the seed. When this is burned off it comes up in dense thickets wherever there is sufficient moisture. It is especially abundant at high elevations; and in the northern hills, on extensive burnt areas, it forms an important part of the second growth. This is shown on Pl. XXV, *B*. In Wyoming, on the extensive burn south of Sand Creek, aspen covers hundreds of acres in the rich ravines. It attains a larger size on the western than on the eastern slopes of the hills. In the latter section it is usually 3 to 6 inches in diameter and about 30 feet high, although sometimes trees a foot in diameter are found. In Wyoming trees a foot in diameter are very common, and one specimen was found 23.5 inches in diameter, breast high, and 50 to 60 feet in height.

Another tree which springs up readily after fires, particularly at higher elevations, is the white birch. Like aspen, it sprouts readily from the stump. It is seldom over 4 inches in diameter, although occasional trees were seen as large as 8 inches. It has no economic value.

At low elevations, chiefly in ravines and canyons, bur oak is a characteristic tree. It attains a diameter of nearly 2 feet and a height of about 45 feet. Several trees were seen with stems clear enough for one log, but it is usually very scrubby and the timber coarse. The largest specimens were seen near Keystone. The average size of the oak is 6 to 10 inches in diameter and about 30 feet in height. It sprouts readily, and a large number of the older oaks are sprouts which have come up from the stump after fire. The oak is found chiefly north of French Creek, and is very abundant on Squaw, French, Bear Butte, and

Spearfish creeks, and in the Bear Lodge Mountains. It is found as a shrub on the Spearfish Divide, and in Wyoming scrub bur oaks form a large part of the second growth on the ridges after fires.

In the canyons and ravines in the foothills of the eastern and northeastern portion of the hills, below an elevation of 4,500 feet, ironwood occurs scattered among oaks and aspens. It is small and usually twisted; the young sprouts are usually straighter than the older specimens. Ironwood is sometimes used for tool handles.

Box elder has a very general distribution on the streams throughout the hills below 5,000 feet. It is small, and branches near the ground. It occurs nowhere in large numbers and is of no economic importance.

Elm occurs in small numbers on the northern and eastern hills. It is found in canyons and ravines below 5,000 feet. The highest point at which it was seen was on Rapid Creek between Mystic and Silver City. On Battle Creek, near Keystone, specimens over 12 inches in diameter were seen, but usually it is not over 6 to 8 inches.

At the edge of the timber along the creeks in the eastern portion of the hills were seen a number of specimens of red ash (*Fraxinus pennsylvanica* Marsh). On Victoria Gulch, a tributary of Big Rapid, several specimens of green ash (*Fraxinus lanceolata* Borkh.) were found. These, like the red ash, were not over 6 to 8 inches in diameter. Ash is used for posts.

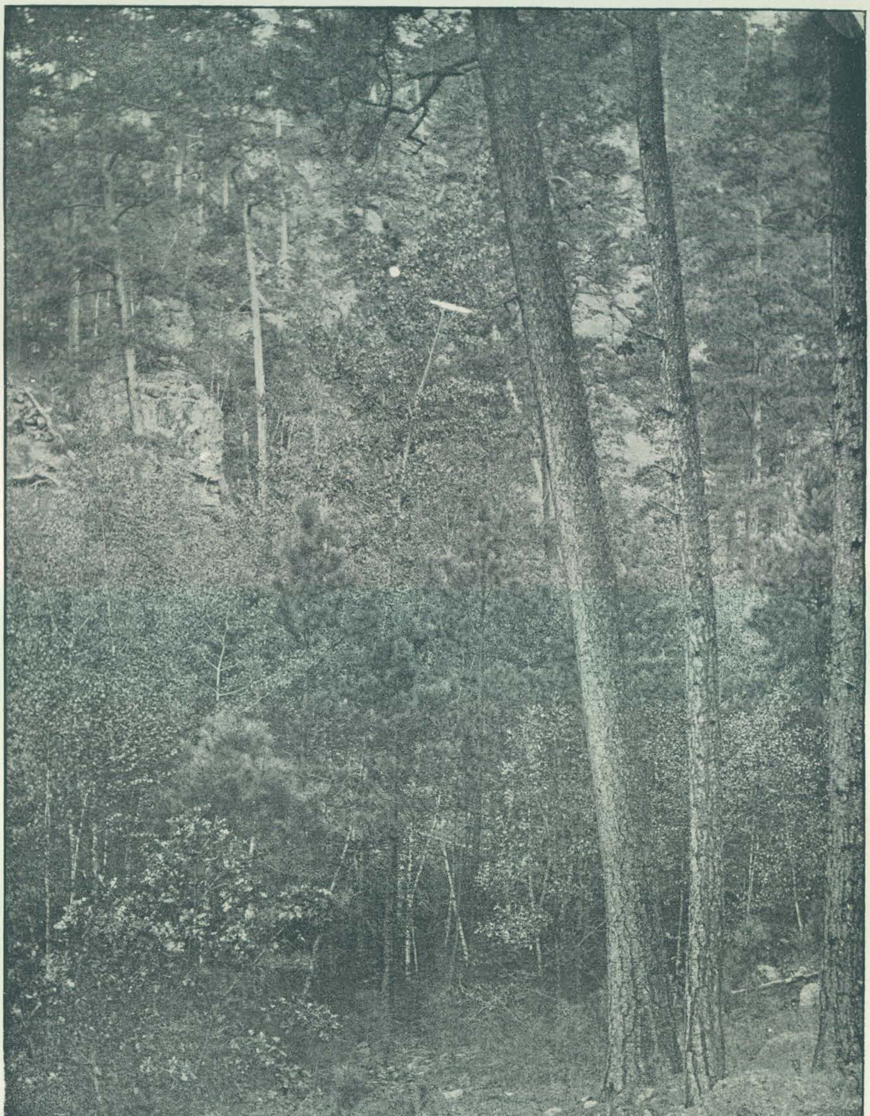
The distribution of red cedar is interesting. It is found on high pinnacles above Castle Creek, at an elevation of 6,000 feet; on the high divide above Spearfish Canyon; on the high limestone plateaus above lower Spring Creek; and it finds its greatest development on the brakes at the edge of the prairie. At high elevations it is small, and only scattered individuals are seen; at the edge of the prairie it is often a foot in diameter, and is largely used for posts and rails. In Wyoming, on Pine Ridge, and in the Inyankara country it occurs in intimate mixture with yellow pine.

Common cottonwood occurs in the foothills all about the mountains. It was seen in Hell Canyon, Cold Brook Canyon, and in the northern foothills. The narrow-leaf cottonwood was found in Spearfish Canyon. It is used for fuel.

Black birch (*Betula occidentalis* Hook) and dwarf birch (*Betula glandulosa* Mx.) were seen in small numbers on Little Rapid Creek and tributaries.

Along the canyon bottoms willows grow in profusion in all parts of the hills, and hazel (*Corylus rostrata* Ait.), dogwood (*Cornus stolonifera* Mx.), service berry (*Amelanchier alnifolia* Nutt.), choke cherry (*Prunus demissa* Nutt., and *P. virginiana* L.), pin cherry (*Prunus pennsylvanica* L.), and hawthorn (*Cratægus macrantha* (Lindl.) Loud), are to be mentioned among the shrubs growing along ravine and canyon bottoms.

The most characteristic plant growing in pine forests is the bearberry (*Arctostaphylos uva-ursi* Spreng.), which is found everywhere in the



A CHARACTERISTIC FOREST IN A DEEP, NARROW RAVINE AT AN ELEVATION OF ABOUT 4,000 FEET.

Black Hills. It occurs in very dense forests, where other undergrowth will not live. Besides this plant, snowberry (*Symphoricarpus racemosus pauciflorus* Robb.) is frequently found in these forests. Service berry is not uncommon, and *Spiræa lucida* Dougl., *Shepherdia canadensis* Nutt., wild rose, and various Leguminosæ form characteristic undergrowth of pine slopes. At high elevations *Ceanothus velutinus* Dougl. and *C. ovatus* Desf., and Oregon grape (*Berberis aquifolium* Pursh.), are common. Note should be made of poison ivy, growing on high ridges, and *Rhus trilobata* Nutt., found on limestone plateaus near the foothills. *Rhus glabra* L. was also seen in the foothills.

At high elevations, under the dense spruce forests, the undergrowth becomes distinctly changed. In such localities the ground is clothed with moss, with *Vaccinium myrtillus microphyllum* Hook, bunchberry (*Cornus canadensis* L.), *Linnæa borealis* L., *Chimaphila umbellata* Nutt., and an occasional salmon berry (*Rubus nutkanus* Mocino). Mountain mahogany (*Cercocarpus parvifolius* Nutt.) is very common in certain sections, especially in the foothills in the southwestern portion of the hills. Wild plum (*Prunus americana* Marsh) is abundant on the foothills, and wild raspberries and strawberries are found in great profusion in the mountains. There are also wild gooseberries and currants in the Black Hills. In the high Limestone Divide *Juniperus nana* Willd. is common, and on the foothills in the northern and northeastern part of the hills a large amount of *Juniperus sabina prostrata* Pers. was noticed.

Besides the shrubs enumerated above, there are innumerable herbaceous plants, which grow in great luxuriance throughout the forest. In the Limestone Range there is an especial profusion of rich herbaceous vegetation in the rich ravines, and even where the forest is rather dense there is a thick growth of long grass.

In the narrow canyons, especially where deciduous trees are growing, there is a thick layer of humus and leaf litter. On ridges and slopes the humus is usually thin. On limestone soil humus is formed more rapidly than on other formations, and when the forest is removed is dissipated more quickly. Limestone soil clothes itself readily with grass and weeds, even in comparatively dense shade. On other formations there is no underbrush in dense pine forests, except some bearberry and a few straggling shrubs and forest weeds.

MOUNTAIN PRAIRIES AND PARKS.

There are within the hills a number of mountain or high prairies, varying from several hundred to several thousand acres in extent. These prairies are surrounded by timber, but are themselves devoid of all tree vegetation. There is a rich covering of grass and herbaceous plants, which are excellent for grazing. The most important prairies are Reynolds Prairie, Slate Creek Prairie, Bald Mountain Prairie, Gillette Prairie, Custer Prairie, and Canyon Springs Prairie. These areas are called prairies, but they are artificial rather than natural prairies—that is, there are no natural causes which prevent trees from growing. There is sufficient moisture in the soil and atmosphere, and there are no poisonous salts in the soil which are injurious to tree growth. These statements are derived from general observation, not from actual analysis of the soil; and no meteorological comparisons have been made within and without the prairies. The statements are based on the following facts:

1. Topographically the prairies are similar to the surrounding wooded country, not differing in elevation, geological formation, or general character of soil.

2. The prairies are, as a rule, surrounded by dense forests terminating abruptly at their edges and composed of trees of as large size and vigorous growth as half a mile away.

3. In many places the forest is encroaching on the edge of the prairie.

4. On Bald Mountain Prairie there are patches of fine trees within its limits and a few traces of old trees in the form of charred sticks and old roots.

Presumably these tracts were once covered with a forest which has been wiped out by fires. In every case the surrounding country shows the effects of old and severe fires. The probability is that these particular areas were more severely burned than the surrounding country, the forest killed, and in the frequent fires following the dead material has been consumed even to the roots of the trees. Frequent succeeding fires have kept down the young growth, and the soil has become compact and clothed with a dense covering of long grass. Since white men came into the country the constant grazing of stock has tended to compact the soil and prevent reforestation. The first cause of the absence of trees, then, is fire; the second, a change in the physical character of the soil, and chiefly in the soil covering, which prevents the germination of seed.

It has been observed that the few trees or seedlings scattered within the prairies are near points where the underlying rocks are exposed and are becoming disintegrated and forming new loose soil. It has also been observed that on the slopes of some river terraces, where the soil is loose, pine has taken root, but upon the top of the terraces there are no trees whatever. It was also observed that in many places a line of young growth is springing up along old, unused wagon tracks, where the soil has been broken up and loosened.

Small prairies of a few acres in extent, especially when occurring along streams and swales at the heads of streams, are called parks. They are nothing more nor less than prairies, like those just described, and have been brought into their present condition by the same causes. These parks are most common in the Limestone Range along the creeks, and especially at their heads. They vary from a few to several hundred feet in width and are often very long. They are covered with thick grass, like the prairies, and often with scattered willows and quaking aspen. The history of a park is as follows: A severe fire destroys the original timber. On the slopes a second growth of pine springs up; on the bottom land a dense growth of aspen, willow, and perhaps a few pines. Other succeeding fires help to destroy the crop of aspens, which keep returning, probably by sprouting. The soil clothes itself with a dense sod of long, rank grass; the growth of aspen becomes thinner and thinner till the stools are killed and the soil reaches the stage where the reproduction of trees is exceedingly difficult. A few aspens remain on the edges of the swale or along the creek; there are perhaps a few scattered willows along the creek, and the rest is a grass park. The reason that the slopes come up to pine is that the soil is thin, is kept loose by rolling stones or newly disintegrated rock, and does not take on a covering of grass as readily as that on the lower slopes and the bottom of the swale. The history of the formation of parks is not mere theory, but observations were made in different parts of the hills of all stages of the formation above described, from the original forest, the scattered fire-scarred veterans with the younger growth of willow and aspen, the second and third crop of aspen scattered, dying, or dead, with the charred poles on the ground, to the complete park. It is not difficult to see how the great burnt tracts in the northern hills might become bald mountains or high prairies if repeated fires should kill the young growth and consume the mass of dead poles and pitch logs. The hills near Deadwood were burned in this way, and those near Englewood and Mineral Springs could easily be brought into the same condition.

On the edge of the hills, where the forest begins to dwindle and run out, there is an abundance of park and prairie land, both natural and artificial. The line of natural prairie has probably been pushed back all about the hills. Where the tree vegetation is in the ravines and on northern slopes alone, probably the edge of the natural prairie is close at hand—that is, prairie caused by the lack of moisture. Where the tree vegetation is on the ridges and slopes, but not in the valley, the prairie has probably been caused by fires.

FOREST FIRES.

Aside from a few restricted areas, practically the whole forest shows traces of forest fires, and usually some actual injury caused by them. There have been periods, separated by about half a century, when the whole or a large part of the hills has been burned over. The oldest fire of which any definite record could be obtained occurred about 1730 or 1740. This date was determined by means of the fire scars on the stumps. There are, further, a large number of trees about 160 to 170 years old, which presumably started in the openings made by fires at that time. Pl. XX, *B*, shows the cross section of a tree over 200 years old which was badly burned by the fire just mentioned and which has succeeded in entirely healing over the severe wound. As will be seen in the photograph, the date of the fire can be readily fixed by counting the number of annual rings from the bark to the part which was injured by the fire. In spite of the healing over of the wound, decay has crept in, and the first log is unfit for lumber. Traces of this fire are found near Rochford, Mystic, on Squaw Creek, in the forests south of Custer, and in the Limestone Range. In all probability this fire, or fires about this time, swept through nearly the whole Black Hills of both South Dakota and Wyoming.

Probably the hills were frequently burned after that period, but no fire of so great extent occurred until about 1790 to 1800, when a great fire, or series of fires, burned over a large part of the range. The second-growth forest in the Limestone Range and northern hills, much of which has been cleared for mining purposes, dates from that time. The scars from this fire are found on old trees throughout the hills, and patches of forest 100 to 110 years old are everywhere to be found. No fire since this period has burned over so large areas or proved so disastrous to the timber. What occurred before this time can only be conjectured, but it is reasonable to suppose that there have always been fires of greater or less frequency and severity.

For the next large fire we have some actual evidence. The Indians tell of a time, between fifty and sixty years ago, when the entire hills were ablaze. The statement must, of course, be taken to mean merely that there was an unusually great fire. Mr. J. C. Sherman, of Pactola, one of the older residents of the hills, informed me that in earlier days he had talked with the Indians in regard to this fire; that they dated it 1842; and that it was formerly a custom among the Indians to set lines of fire at certain times of the year to drive out game. In the northern hills there are many trees and groups of trees about 50 years old, which without doubt had their origin with this fire. In the southern hills the greater amount of sapling growth is about 40 years old. There were probably two severe fires, the former burning with greater severity in the northern and the latter in the southern hills.

There was another extensive fire in the Limestone Range twenty-five years ago, the record of which was obtained from the scars on the timber in that region and from the second growth. The soldiers are said to have started a fire about 1875 near Custer, which burned over a large area and proved very disastrous. Since that time different parts of the hills have frequently been burned. In 1881 a large section of the Limestone Range, from Preacher Springs almost to Deadwood, was burned over, and this may have been the fire which destroyed the timber about the Spearfish Canyon. The young growth which is coming up around Terry Peak dates from about that time. There was another fierce fire in this range in 1891. Of more recent years, 1893 seems to have been the most disastrous, when fires burned in the Limestone Range, in the Elk Creek country, and on French and Squaw creeks.

CAUSES OF FIRES.

The causes of the ancient fires above described can only be conjectured. The Indians contend that the great fire about fifty years ago was caused by lightning. They admit, however, that fires used to be set to drive the game into the foothills, and it seems reasonable to suppose that many, if not the majority, of fires were in some way or other started by the Indians.

There are a great number of electrical storms in the Black Hills, and trees killed by lightning are abundant. It sometimes happens that a dead tree or dry stub is struck and ignited, and if there is not an immediate fall of rain a forest fire may result. A number of settlers in the hills report that they have seen fires started in this way. A severe fire near Warren Peaks in 1890 was undoubtedly started by lightning. It is confidently believed, however, that the great majority of forest fires have had their origin through human agency.

Incendiary fires are not common; the majority are started through carelessness. The forest is usually not dense enough to prove a hindrance to prospecting, and no case was reported where a fire had been set to clear the forest for prospecting purposes, as is said to be sometimes the case in the Rocky Mountains. Campers frequently leave their fires burning when breaking camp, and doubtless many disastrous forest fires have been started in this way. As a rule, prospectors are more careful than in the Rocky Mountains.

A large number of fires are started from the railroad. The forest has been cleared for a certain distance on each side of the track and the ground is covered with a thick growth of grass and herbs, which in late summer becomes exceedingly dry and is easily ignited by an insignificant live cinder thrown from a locomotive.

A good many fires have been started by carelessness in burning brush, though this is not so frequent as in countries where forest land is more extensively cleared for farming purposes than in the Black Hills. Fires sometimes escape from burning sawdust heaps, and sawmill men have been accused of setting fires to cover depredations.

The illustration, Pl. XXVIII, *B*, shows a burning sawdust heap at an old sawmill where a disastrous fire was prevented only by the exertions of a rancher living in the vicinity. During 1897 two fires were started from the smokestacks of sawmills, a third was caused by a careless camper, another by a stove, and one was supposed to be incendiary.

EXTENT OF INJURY FROM FIRES.

The majority of fire-scarred trees found throughout the eastern hills were injured by the old fires mentioned above. Very large areas were entirely denuded by these fires, and everywhere trees were severely injured. Often as many as 75 per cent of the trees are damaged at the butt, and sometimes they are burned half through. Pl. XXII, *A*, shows a forest of poles on a high ridge where from 75 to 100 per cent of the trees are injured by fire. The damage often extends 20 to 30 feet above the ground. While the trees sometimes succeed in totally covering the burnt part, it is unusual where so severe injury is done for them to remain perfectly sound. The ability of the yellow pine for occluding or healing over these scars is wonderful. One remarkable case was found where a tree about 6 inches in diameter had been so severely burned that but 3 inches on one side had escaped injury. Not only had the tree succeeded in living, but the new growth had, within about one hundred and sixty years, wrapped itself completely about the injured portion, even inclosing a disk of dead bark. A few years ago this tree was cut down for lumber and was apparently perfectly sound. Frequently these trees which have been so severely burned are broken by heavy winds. Other trees become stag-headed and die. Some heal over the wound and remain sound. In others decay creeps in at the occluded part and eventually unfits the tree for lumber.

On limestone formations there are apt to be extensive areas of level and rolling ground where a fire attains great proportions and burns in the crowns of the trees and destroys everything in its path. Where the country is broken by sharp ridges and deep canyons or ravines fires are checked and merely burn on the surface of the ground. If the old timber is not actually destroyed the damage is considered insignificant. Within a forest where reproduction is good and the annual fall of litter heavy the injury by a light surface fire is not great. The upper undecayed portion of the humus layer is burned off and the most valuable part remains uninjured and, it may be, enriched by the ashes of the burnt leaves and wood. A severe surface fire inflicts great damage on the soil by destroying all the humus and exposing the bare mineral soil or the underlying rock. The extent of injury done by the total destruction of the humus varies under different conditions. It is greater on thin and newly formed soils than on deep soils; greater on dry ridges and slopes than on fresh bottom lands; greater on gravel or sandy soils than on lime and clay soils; greater in broken open forests than where the trees are thick and the ground is shaded; greater where young forests are burned than where the timber standing is old and consequently not so easily killed.

Surface fires cause very serious injury by unfitting the soil for germination of seed and the growth of young plants. Often the ground becomes thickly grassed over and seed finds great difficulty in germinating, or the long grass and rank weeds shade out the young plants as soon as they spring up. Certain shrubs often come up in such dense masses after fires as to hinder reproduction. Ceanothus is an example of this. In Wyoming the dense thickets of dwarfed oaks act in the same manner as a hindrance to reforestation.

One of the chief injuries of fires is the effect on the density of the forest and, in consequence, the quality of future timber. It is well

A. A FOREST OF POLES ABOVE SQUAW CREEK, SOUTH DAKOTA.

B. A SURFACE FIRE NEAR HILL CITY, SOUTH DAKOTA.

known that, if forests are dense, trees have longer bodies and shorter crowns, and therefore more clear lumber, than if the trees had grown apart. If they have grown up with plenty of room to spread, the branches are large and persistent and the timber is coarse and knotty. Forest fires often destroy large tracts of timber, and the trees which seed up the area are so far away that the reproduction is scant, and the young trees are so scattered that the crowns are broad and the timber is very coarse. Often a body of fine second growth is destroyed which was seeded from trees since removed or killed; in these cases the forest is not set back merely the number of years represented by the age of the young growth, but, in addition, by the time required for the ground to become restocked; and, moreover, it is impossible to establish as good a stand as the one destroyed, because the seed trees have been removed. This is further discussed under "Reproduction" (p. 91).

Still another injurious effect of forest fires is the change in the composition of the forest. In the Black Hills, where the yellow pine has almost undisputed sway, the effect is not so serious as in the mixed forests. Pine is, however, replaced by aspen in certain places, and if the fires continue the land finally is reduced to a park or prairie. White birch is another species which occupies burnt ground, especially at high elevations.

FIRES—PREVENTIVE MEASURES.

Forest fires often burn for several days or even weeks before any attempt whatever is made to check them, and then only when personal property is endangered. After a fire has burned for several days it attains such proportions that a large force of men is required to extinguish it, and it usually burns until put out by rain or snow. The Homestake Mining Company has set an admirable example in regard to fighting fires. During the summer of 1897, when a fire was started near Camp 4, this company hired a large body of men and totally extinguished it. One man spent a large amount of time plowing a fire line through the woods in the Limestone Range, and hired a number of men at considerable expense to assist him in the work. On the other hand, there are many who are extremely careless in regard to starting fires and utterly unappreciative of the damage inflicted upon the forest. A conspicuous example of this occurred during the summer of 1897, when a fire started within a hundred yards of a sawmill near Hill City. Practically no attempt was made to put it out and it burned for several weeks, doing a great amount of damage, particularly to the young growth. Fortunately such a spirit of open defiance is not very common, and it is confidently believed that, with a forest service, the most hearty cooperation of settlers would be secured in putting out and preventing forest fires.

The methods of fighting forest fires have been to beat out the flames, dig fire lines, and, in certain cases, back fire. The ground is covered with dry logs which become ignited and are difficult to extinguish. The fire burns in these logs for many days, and sparks from them are blown by the wind and spread the fire, even after it has been thought to be under full control. Dead standing stubs burn easily, and when they break off spread the fire for a distance of 20 to 30 feet.

Tree tops left in the woods constitute a great menace to the safety of the forest. They become dry and, with 20 to 30 large tops per acre, form abundant fuel for forest fires. On hillsides fighting fire is difficult, for ignited cones and logs slide and roll downhill, spreading the fire to fresh fuel. When the wind blows, the fire is often carried as far as half a mile, and even farther, by ignited bark. Always in front of a large fire small fires are springing up here and there. It is often thought that these are incendiary, but they are caused by sparks blown by the wind.

It has been said that fires are seldom totally extinguished. When an attempt to do so is made, and the worst of the fire has been checked, the workmen usually leave it, considering that it is practically out. The following day the wind springs up, the smoldering logs are fanned into life, sparks are blown into fresh fuel, and the fire continues to burn. On limestone slopes the rock often becomes so much heated that it explodes and fire fighting becomes dangerous.

The best way to extinguish an ordinary surface fire is to make a fire line—that is, rake away the leaves and inflammable material from the front of the fire and cut away any logs which may cross the line. A constant watch should be kept along this line to see that no sparks cross. The difficulty has always been that this line has not been properly made, that the sticks and logs have not been cut out, and that the fire has not been watched. There has been no one with the authority and the means to hire men to put out and watch the fire, except where some company, like the Homestake, voluntarily takes the matter in hand and is willing to spend the money necessary to do the work. It is obvious that there should be some system of forest management which will insure protection against fire.

OTHER SOURCES OF INJURY.

WIND.

As a rule, the yellow pine is a very wind-firm species. The side roots take a firm hold upon the ground among the rocks and render the tree capable of resisting severe storms. There have been a number of instances where considerable tracts have been swept by hurricanes. On French Creek there was some years ago a large windfall, and there is said also to have been a tract of timber blown down about ten years ago on Grizzly Creek. Windfalls on a small scale were seen in many places. They occur on exposed ridges, and particularly in micaceous schist and limestone formations. In most cases, where the trees were actually uprooted, the cause lay chiefly in the pulling up of the stones about which the roots had twined themselves. On schist formations, where the rock has a steep dip, the trees are often overturned in this way, pulling up large quantities of this easily broken rock. The same was seen on limestone ridges.

Not only are patches of trees and individuals overturned by the wind by uprooting, but a large number are broken off at the butt. This wind-break is directly traceable to forest fires which have burned the butts of the trees, and the decay, creeping in at the wound, has eventually so weakened them that they are unable to stand the strain of a heavy wind.

LIGHTNING.

Mention has already been made under "Forest fires" of the large number of electrical storms in the Black Hills. Everywhere throughout the hills there were seen trees which had been killed by lightning. On exposed ridges the damage is very great. While a large number of trees are killed by lightning, the chief danger lies in the setting of forest fires.

INSECTS.

On the high Limestone Divide, from near Crook Tower to the head of Little Spearfish Creek, there are numerous patches of dead and dying timber. These patches are usually rectangular in shape and follow the tops of the divide and ridges, or run lengthwise up and down the slope. This forest has for the most part not been lately burned, and there is a heavy matting of litter and humus on the ground. The injury is confined to the limestone formation and to high elevations. The trees are in many cases second growth and apparently perfectly thrifty. This injury is probably caused by insects. On all dead and dying trees examined were found bark borers, a species of the Scolytidæ, working under the bark. In most cases the leaves were clinging to trees which had been dead for several seasons. While these borers do not as a rule attack vigorous trees, no other cause of the death of this timber could be found.

It is estimated that about 3,000 acres of timber have been killed in this way.

SMOKE.

At Deadwood, near the large mills, a considerable amount of young timber shows a browning of the foliage, and in many cases the young trees are dying. These trees are exposed to smoke and fumes from the mills, and the death of the leaves, and subsequently of the trees, is due to this cause. This is a common phenomenon near factories, both in this country and in Europe. Prof. Robert Hartig, of Munich, has made an extensive investigation of the injury and has shown that it is due to the death of the stomata cells of the leaves through the action of the sulphurous acid in the smoke. The amount of forest in the Black Hills injured in this way is insignificant.

LUMBERING.

The first sawmills were brought into the Black Hills about twenty years ago. These mills were small and manufactured what lumber was needed by the miners and scattered ranchers. The sawmill business received a special impulse when the railroad was built through the hills, and since that time large amounts of timber have been annually manufactured into lumber. The railroad opened up a market for lumber, and the mills have been rapidly increasing in number, until there are now 42 sawmills in operation in the South Dakota portion of the hills. These are small portable mills, capable of producing, as a rule, about 8,000 to 10,000 feet of lumber per day when in full operation. Very few of the mills, however, run at their full capacity. The largest mills saw 1,500,000 feet annually; the smaller mills not over 200,000 to 300,000 feet. There are 2 mills which saw about 1,500,000 feet each year, 3 which saw about 1,000,000, 3 about 800,000, 19 about 500,000, 8 about 400,000, and 5 about 200,000. The average annual output of saw lumber is estimated at 20,000,000 feet.

In the early days, when mills were few and accessible lumber was plentiful, only the best trees were cut, and from these only the clearest logs taken. Sawmills are in many cases working over this land a second time and taking out even a larger amount per acre than was first cut. Doubtless in years to come these lands will again be cut over as the size limit of saw logs is lowered. At present 14 inches in the stump is about the minimum limit of merchantable timber, and as a rule these trees must produce 2 logs if they are taken. Where shingles and laths are worked up, trees may be taken down to 12 inches and even less. In general the trees yield about 1½ logs each. The logs must be 10 inches in diameter at the small end for saw lumber.

The laws in regard to cutting timber on the public lands are so loose and the provisions for enforcing them so inadequate that there has been no check to the reckless waste of timber which has been going on for years. If a few spots of decay are found, or the logs prove too knotty, they are condemned, and either the whole tree is left lying in the woods or only one log is taken. Furthermore, lumbermen have been utterly reckless in cutting more timber than they could saw. Instances have been known where trees have been cut down in order that some other mill man might not secure them. Afterwards only a portion of the timber was needed and a large number of the finest trees were left to decay. One case is reported, near Mystic, where several thousand logs were cut to supply a possible demand by the Minnesota mine. The mine meanwhile closed down and the logs lie to-day rotting in the woods. Great masses of decaying saw logs were seen on Gimlet Creek, Big Rapids, in the forest near Pactola, west of Custer, between Custer and Pringle, and on Box Elder Creek.

Before condemning the lumbermen, it is necessary to understand the condition of the lumber business in the Black Hills. While the fear-

A. WASTEFUL METHODS OF LUMBERING.

B. WASTEFUL METHODS OF LUMBERING NEAR HILL CITY, SOUTH DAKOTA.

ful waste that is going on is to be deplored, it is fair to say that it is not so much due to wantonness on the part of the lumber operators as to the present system of control of the forest lands, the inability of the Department to enforce the laws, the high freight tariffs, and the competition among lumbermen and consequent inadequate prices of lumber. It is a notorious fact that thousands of feet of lumber are annually shipped out of the State contrary to the law. The special agents have endeavored to enforce the law in this respect, but as yet the Department has utterly failed in putting more than a temporary check on the traffic.

A glance at the prices of lumber will be sufficient to show that the lumbermen are forced to take only what will make the best lumber in order to keep their mills running. At Custer mill men receive about $10 per thousand feet for clear lumber, $7 to $8 for stock, $6.50 for dimension, and $6 for sheeting. It costs them about $2.50 to $3 per thousand feet to put in the logs, about $1.75 to saw them, and $1.25 to $2 to haul the lumber to market. One man informed me that he was receiving $7 per thousand for clear lumber after hauling it 7 miles. He was selling stock at $5.50 and dimension at $4.50. In the northern hills the prices are somewhat better. Thus on Box Elder clear lumber is sold for $12 per thousand at the mill and stock lumber for $10. The choppers are paid by the thousand feet for cutting logs, and naturally they will saw up only what will be accepted at the mill.

According to the law the lumbermen are required to use all material possible in the tree, to remove the tops, and pile and burn the brush. In the southern hills the lumbermen can not dispose of more than a limited amount of cord wood. In Custer cord wood brings $2 per cord and in Deadwood $4. For those mills at some distance from the railroad it is impossible to dispose of all the cord wood in the tops without losing money. Freights are so high that the price of cord wood in Deadwood would just about pay for hauling and shipping from Custer. The mills operating close to the railroad in the northern hills can afford to cut up the tops. The Homestake Company is carrying out the law in this regard. This company requires a large amount of cord wood, and it is said that this amount will be very nearly supplied from the tops left after cutting saw logs and mine timbers at their own camps. They pay $1 per cord for cutting the tops and piling the brush.

On an average, about 50 per cent of each tree cut for lumber is left in the woods. It is estimated that fully 1½ cords are left in the woods for every thousand feet utilized. It is safe to say that no less than 30,000 cords of wood are annually left in the forest in the form of tops, and the greater portion of this material is wasted, though some of it is afterwards cut up for fuel by the ranchers.

The following measurements of trees cut for lumber are instructive:

Measurements of trees cut for lumber.

Diameter on stump (inches).	Board feet.	Cord wood left (cords).	Per cent utilized.	Number of logs.
19	185	0.06	36	1
18	206	.09	83	2
22	432	.07	49	2
17	178	.25	54	1
18	287	.15	81	2
21	208	.04	48	1
18	160	.38	43	1
19	208	.38	48	1
16	172	.24	58	1
17	128	.37	34	1

In the northern hills the conditions are somewhat different from those in the central and southern portions. The center of population in the Black Hills is near Deadwood and Lead, and the demand for timber of all classes since the settlement of the country has been very large. The timber has been almost entirely cut within a radius of 8 miles from Deadwood. The nearest accessible timber is for the most part comparatively young and not yet large enough for anything but cord wood and mine props. Much of this timber, composed of young, thrifty poles, is being cut for fuel which ought to be reserved for the future supply of lumber, while farther south thousands of cords of wood are wasted annually.

There are three classes of timber used in the mines: 11-inch flats, which are 11 inches in thickness with a face of about 6 inches; 6-inch flats, or lagging; and 3-inch flats, which are used in some of the smaller mines for tunnels. Trees about 14 to 18 inches on the stump are used for the 11-inch flats, and trees 8 to 14 inches for lagging. Trees which are too knotty for lumber may be used for mine props, but they must be sound. A much larger percentage of each tree is utilized where mine timbers are cut than when cut for lumber. The cost of lumbering mine timbers is $2.50 per hundred feet for cutting and skidding 11-inch flats and $1.25 per hundred for lagging. The timbers are cut in 12-foot and 18-foot lengths and are afterwards sawed into 6-foot lengths at the mines.

The Homestake Company requires annually 750,000 linear feet of 11-inch flats and 1,000,000 feet of lagging. This company has 3 wood camps in operation to take out mine timbers. The Holy Terror Mining Company uses 1,200,000 linear feet of props annually, and the Keystone Company fully as much when in operation. It is estimated that 4,500,000 linear feet of mine timbers of all classes are consumed annually in the Black Hills.

A. AN OLD SAWMILL NEAR CUSTER, SOUTH DAKOTA, SHOWING THE AMOUNT OF MATERIAL OFTEN WASTED BY THE LUMBERMEN.

B. WASTEFUL METHODS OF LUMBERING.

Formerly a very large amount of cord wood was used in the stamp mills, and a great deal of the timber cut by the Homestake Company on Elk Creek was used for that purpose. Most of the mills and hoisting works in the northern hills now use coal, although there is always a certain amount of cord wood consumed. At present the only mines which use much cord wood are those situated away from the railroad. Ordinarily a 20-stamp mill will consume 8 cords of wood per day. The Holy Terror mine requires about 3,600 cords of wood per annum and the Keystone mine about the same amount. It is estimated that for milling alone the annual consumption of cord wood is fully 25,000 cords. In the South Dakota portion of the Black Hills there is a population of about 40,000 people, based on the last election, allowing 4 to each voter. A family uses on an average 10 to 15 cords of wood annually. On this basis the annual consumption of stove wood may safely be placed at 100,000 cords.

In Wyoming there are 7 sawmills in operation. It is estimated that there are manufactured annually by these mills about 3,000,000 feet of lumber.

REPRODUCTION OF YELLOW PINE.

One of the most important considerations in connection with the practicability of forest management is the ease and certainty with which a forest, and particularly the most valuable species, may be naturally reproduced. Without a knowledge of the way in which the forest reproduces itself we can not appreciate the injury by wasteful methods of cutting and by fire, and we can not establish a correct system of forest management. In the present case we have to do virtually with but one species of tree, the yellow pine, so that there are no complications in regard to having the young growth crowded by other and less valuable species. While the investigation was too broad and general to determine any distinct recurrence of seed years, they are sufficiently common to assure a full crop where the soil conditions are favorable. The young growth comes up in compact masses and is so dense in favorable conditions as to compare with the lodgepole pine in the Rocky Mountains. One such dense growth of saplings about 10 feet high was estimated to have between 7,000 and 8,000 trees per acre. Pl. XXV, *A*, shows the excellent reproduction where the soil conditions are favorable. The best reproduction is found in broken forests where scattered trees remain evenly distributed over the area, or in small groups 25 to 50 feet square, or in strips of the same width. In such small groups or strips the young growth extends under the boundary trees. Good reproduction is found in an opening as large, or a strip as wide, as 1 square acre. On patches larger or strips wider than about a square acre the body of young growth is apt to be broken, but where seed trees are scattered over the area the size of the plot over which there is good reproduction is unlimited. Upon large clearings the reproduction is poor, not only on account of the deterioration of the soil under exposure, but also on account of the distance of the seed trees. Pl. XXV, *B*, shows the young pine which comes up on a large clearing. It will be seen that the trees are some distance apart and are covered with limbs almost to the ground, and will form timber of very coarse character. Pl. XXXIII, *B*, is a view near Englewood, where in the early days the timber was completely removed for mining purposes and the entire area cleared. The second growth is for the most part scattered, open, and will produce scrubby, coarse timber.

The most favorable condition for the germination of the seed and life of the seedling is where the mineral soil with an admixture of vegetable humus is exposed. This condition is found where the upper layer of litter has been removed by fire or otherwise and the upper layer of soil is well mixed with the vegetable mold. The conditions for germination are not so favorable where the bare mineral soil is exposed, especially if the soil be sand and gravel. If the soil becomes covered with a thick sod and high grass the pine finds great difficulty in obtaining a footing. If the litter is too thick, either the seed does not germinate or it molds, or the roots do not succeed in reaching the mineral soil. Thus it is that in the bottom of canyons, where there is a heavy matting of leaves and decayed vegetation, the reproduction is very poor. A full explanation has already been given of the difficulty of reproduction on parks and prairies on account of the soil covering.

The geological formation has an effect upon the reproduction of the forest in so far as the soil formed is lime, clay, or sand and gravel. The receptivity of the soil for the seed is much more easily disturbed on limestone soil than on other formations. Lime soil is very productive and clothes itself with grass even in moderate shade, thus passing over to the stage found in the parks more easily than on other formations. As a rule, the reproduction is best on northern slopes, in shallow depressions, and at the heads of ravines. It is good on moderate slopes and on flats and ridges where the soil is not too stony. Pine reproduces itself well after a light surface fire. A severe fire usually injures the soil by destroying the humus.

Not only must there be a favorable condition of the soil for good reproduction, but there must also be a certain amount of light. Pine generally reproduces itself in broken forests, in openings on the edges of forests, and on slopes in fairly dense forests. In the last case there is enough side light admitted for the young plants to survive. Absolute altitude does not have much effect upon reproduction within the limits of the hills. It is difficult to determine exactly the effect of lumbering on reproduction. In almost all cases where good reproduction is found after lumbering there have been light fires. In other cases it was not possible to tell whether the fires had passed over the area before or after the cutting. Pl. XXVIII, *A*, shows excellent reproduction after lumbering, but where it is believed that a fire also passed over the area.

A. EXCELLENT REGROWTH OF YELLOW PINE NEAR THE HEAD OF A RAVINE, AT AN ELEVATION OF ABOUT 5,000 FEET.

B. SECOND GROWTH ON LAND CLEARED BY THE HOMESTAKE COMPANY, NEAR ENGLEWOOD, SOUTH DAKOTA.

GROWTH OF YELLOW PINE.

It was manifestly impossible within the limits of the present investigation to collect enough data for an exhaustive study of the growth of the yellow pine. It is necessary, however, for a proper consideration of forest management in the Black Hills, to know something of the growth of the principal tree. For the present purpose it is essential to know primarily the rate of growth in diameter. While the growth in height is interesting, especially in dealing with mixed forests, it is in this case of less immediate importance than the diameter growth, inasmuch as we are dealing with a nearly pure forest. If a sufficiently dense forest is established the height growth will take care of itself, so that we may be sure that by the time a sufficiently large diameter is attained the tree will be tall enough to form merchantable timber. We are interested further in knowing the rate of growth of trees in the forest under average conditions, and not what an isolated individual growing on rich soil can produce. The greater portion of the forest is growing on slopes and ridges with relatively unproductive soil. The rate of growth is comparatively rapid on rich flats and canyon bottoms, and these are the places where lumbering has been most in progress, and where there are the most stumps which afford an opportunity for the study of the growth. Stumps with rapid growth are much easier to count than those of slow-growing trees, and there is always a temptation to use such for the study of average growth, and in this way place the figures too high. Great caution was used in this case in choosing the stumps which should form a basis for the study of growth, and it was the aim to use only such as represent average conditions and not such as would give maximum figures. Measurements of 14 stumps were taken to determine the diameter growth, and it is believed that they fairly represent the average growth, so far as this can be determined at all from a restricted number of measurements.

The following is a summarized table of the measurements:

Summary of stump measurements.

Diameter inside bark.	Height of stump.	Age on stump.	Locality.	Situation.	Growth last 10 years.
Inches.	*Inches.*				*Inches.*
18	30	118	Rockerville	High flat	0.4
12.2	20	94	do	Moderate slope	1.6
11.2	10	93	Otis	10° slope	1.6
11	36	93	Lightning Creek	5° slope	1.2
10.5	18	102	Keystone	15° slope	1.2
14	18	111	Limestone	Flat	1
20	36	138	Dumont Divide	do	
14.7	30	94	Rochford	10° slope	.7
8	10	50	do	do	1.6

Summary of stump measurements—Continued.

Diameter inside bark.	Height of stump.	Age on stump.	Locality.	Situation.	Growth last 10 years.
Inches.	*Inches.*				*Inches.*
18	24	157	Head Rapid Creek...	High flat..........	.7
15	24	99	.....do	Low slope.........	.6
21	30	161	Limestone	....	.6
18	24	165	Grizzly Bear	10° slope..........	1.4
15	24	130	Horse Creek.........	.....do	.6

In order to obtain an average of the data above summarized, the progress of the diameter growth of each tree was plotted on cross-section paper. The number of years were laid off on the horizontal lines and the number of inches on the vertical lines. A normal curve was drawn through the points on the cross-section paper, and in this way the average growth was obtained. This curve is given in fig. 1. The values taken from the curve are in the table following.

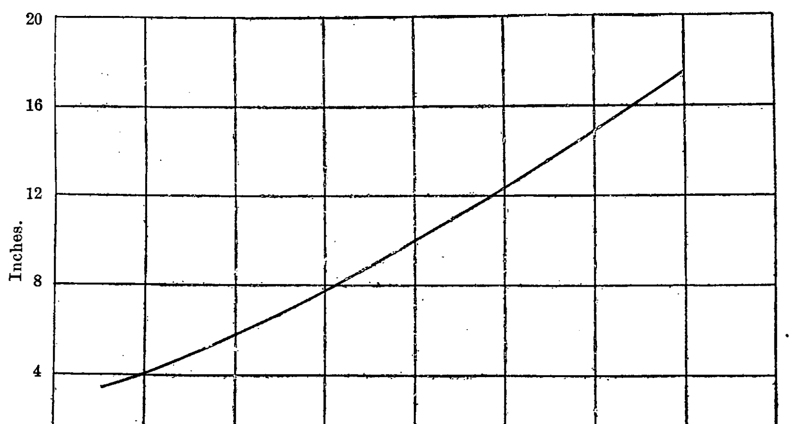


FIG. 1.—Curve showing the average growth in diameter of the yellow pine.

Growth in diameter.

Age.	Diameter.	Age.	Diameter.	Age.	Diameter.	Age.	Diameter.	Age.	Diameter.
Years.	*Inches.*	*Years.*	*Inches.*	*Years.*	*Inches.*	*Years.*	*Inches.*	*Years.*	*Inches.*
20	2.4	50	6.3	80	10	110	13.3	140	15.9
30	3.9	60	7.6	90	11.1	120	14.2	150	16.6
40	5	70	8.8	100	12.2	130	15.1		

From this table may be seen, first, that under average conditions timber large enough for saw lumber can not be produced under 150 years. By this we mean under the present system of lumbering. A merchantable stand of timber should have an average diameter of at least 17 inches on the stump. In all probability the size limit will steadily decrease, and before many years, as the timber becomes scarcer, an average diameter of 15 inches may suffice. Second, that about 40 to 50 years will be required for the greater part of the second-growth forest now found through the hills, which is about 100 years old, to become large enough for the saw. Third, that mine timbers can be produced in 80 to 100 years.

These facts give us a basis for the consideration of forest management from a new standpoint. The questions of the rotation of the pine—that is, the average age which the forest is expected to attain before being cut down—the severity of cutting which may safely be allowed, and the size limits to be determined under which no timber should be cut, cease to be guesswork or generalizations based on observations in other places where the conditions are totally unlike those in the Black Hills. These questions are discussed under "Forest management" (pp. 96–99).

It is to be distinctly understood that the table given above is based on a restricted number of measurements, and that no further claim is made for it than that it forms a provisional study of the growth of the pine designed to answer certain questions regarding the introduction of forest management, and for the purpose in hand is sufficiently comprehensive.

YIELD.

The yield per acre of merchantable timber is very small for a pure pine forest. Attention has already been called to the unsound condition of the timber and the large proportion of second growth not yet of merchantable size, as well as the small percentage of each tree used for lumber. These facts must be taken into consideration in making an estimate of standing timber. In some places the forest will average 15,000 to 20,000 feet per acre, but such localities are very restricted in area. In general a district which will yield 5,000 feet of lumber per acre over the whole area is very good. The average yield in original forest is probably not over 4,000 feet per acre.

In order to present more clearly the condition of the forest in different sections and to verify the estimate, sample plots, usually one-half acre in extent, were paced off and the trees counted. The trees were classified as sound and straight, scrubby or defective, and dead, and the diameters estimated. These valuation surveys are summarized in the various regional descriptions.

The following summary gives a rough estimate of standing timber in the entire forest of the Black Hills:

Estimate of standing timber in the Black Hills forest.

Region.	Area in timber limits.	Cut over.	Saw lumber.	Other material.
	Sq. miles.	*Sq. miles.*	*Million ft.*	*M cords.*
Beaver Creek	104.9	12.4	23	800
Pleasant Valley	64.8	41.2	40	400
Hell Canyon	81.8	0	57	800
Red Bird	121	0	34	900
French Creek	97.2	61.7	62	900
Squaw Creek	40.8	8.9	56	400
Battle Creek	68.7	12.4	98	700
Spring Creek	166.4	80.8	65	1,200
Big Rapid Creek	110.8	18.7	80	900
Slate Creek	39.6	18	32	350
Castle Creek	155.2	.8	50	1,200
Little Rapid Creek	101	22.3	30	350
Box Elder Creek	136.6	17.3	95	1,000
Elk Creek	93.8	75	10	250
Bear Butte Creek and Whitewood	137.4	97	10	200
Spearfish	199.3	11.8	150	1,300
Cold Springs	330.6	6.4	550	2,500
Total	2,049.9	404.7	1,442	13,150
Bear Lodge	Unknown.	....	50	....
Inyankara	6.4	....	2	40
Pisgah Hills	22.2	....	8	125
Pine Ridge	9	....	0	45

FOREST MANAGEMENT.

Probably no one who is at all familiar with the conditions of the Black Hills will deny the urgent need of protection against fires, wasteful methods of lumbering, and timber frauds. The establishment of some system which will bring about such protection is the first and most necessary step in forest management. Forestry contemplates, however, something further than mere police patrol and enforcement of the forest laws. It has in view the establishment of forests to take the place of those which are being cut off and the eventual utilization of the forest soil to its full capacity. This can not be brought about by merely enforcing the forest laws and keeping out fires, but requires the intelligent direction and control of lumbering with the reproduction of the forest in mind.

Forest management in the Black Hills becomes simplified for the following reasons:

1. There is a steady market for forest products—lumber, mine timbers, ties, and fuel.
2. The natural reproduction of the predominant species is excellent.
3. The forest is composed of trees of all ages.
4. There is an excellent system of roads.
5. The residents are in favor of some system of forest protection.

The consumption of forest products, as well as natural reproduction, has been discussed at length. The fact that there is a large body of second-growth timber is a much more important factor in forest management than would at first appear. The old forest is composed of trees which are mature and which should be used as rapidly as there is a demand for them. The presence of a large amount of second-growth timber makes this possible without danger of a shortage of timber in the future. It is estimated that there is sufficient second growth to take the place of the old timber by the time the latter is cut off, provided there is a conservative system of management to secure economy in the use of the old timber and protection for the second growth. If the reckless waste that is now going on in lumbering, the slashing of second-growth forests for cord wood, and the forest fires continue, the exhaustion of the timber supply is merely a matter of time. If economic forest management is introduced in the Black Hills, there is no reason why the timber supply should not hold out an indefinite period.

The object of forest management is to produce forest products in as short a time as possible. If it is possible to introduce a system by which lumber may be obtained in less than 150 years, and all classes of mine timbers in less than 100 years, there can be no question of the profitable character of systematic forestry.

The veteran forest is composed of four classes of trees: (1) Large trees suitable for lumber; (2) large trees suitable for mine timbers and cord wood; (3) scrubby and defective poles; (4) thrifty, straight, clear-boled trees not yet large enough for lumber.

Under the present system the trees of the first class are removed by the first cutting, and if the area is cut over for mine timbers, some of the second class and all of the fourth class are taken down to 8 inches on the stump. The forest which remains is composed of scrubby and defective trees. Unless there happen to be patches of second growth on the area there will be no saw lumber until a new crop is established and grows to merchantable size, which will be about 150 years if the minimum size for saw logs remains the same as at present. If, on the other hand, the straight thrifty poles under 12 inches on the stump are left standing as reserves, there will be saw lumber on the area in 50 to 100 years. The best results would be obtained if all timber except these thrifty poles were removed, for the reserves, which would average 20 to 40 per acre, would seed the ground to a new crop, and there would be no valueless defective trees to occupy the ground and hinder the development of the young growth. In order to make this proposition clearer the following half acre, near the head of Slate Creek, may be used as an example:

Condition of half an acre of forest near the head of Slate Creek.

Diameter (inches).	Clear, straight trees.	Scrubby trees.	Dead trees.
8	10	2	
10	9	2	
12	12	1	1
14	6	1	
16	4	4	
18	8	5	
20	2	4	
22		1	
24	1		1
26		1	

There are on this half acre 21 trees 14 inches and over in diameter suitable for logs and yielding 4,200 board feet; 12 straight thrifty trees 12 inches and 19 under 12 inches in diameter, that are suitable for logging, and 23 trees suitable for cord wood and mine timbers.

If all the trees are cut but the 19 thrifty poles and the ground is successfully seeded to pine, and 15 trees are left as reserves, there will be in one hundred years not only a crop of trees suitable for mine props, but also about 3,000 feet of lumber. If all trees had been cut to the present limit allowed by law, 8 inches, it would require about one hundred and fifty years to produce a crop of lumber.

Pl. XXVI shows a forest of poles with scattered veterans, such as would result from this system of cutting. It may be said also that the reserved trees would be, as a rule, scattered, and that they would for the rest of their lives be exposed to the full influence of light and space, and would therefore grow more rapidly in diameter than if surrounded or overtopped by large trees.

In many places there is not a sufficient demand for cord wood to warrant the removal of the scrubby trees. In such places the system could be carried out at present so far as to reserve the thrifty straight poles under 12 inches, but wherever it is possible to dispose of the material everything should be cut but the reserved trees and any small

A DENSE FOREST OF POLES 8 TO 10 INCHES IN DIAMETER, WITH ONE OF THE MOTHER TREES IN THE CENTER, REYNOLDS GULCH, SOUTH DAKOTA.

growth which happens to be on the area. The reserved trees should be marked under the direction of the forest officer in charge of the reservation. If it should seem wise to manage certain lands for the production of mine timbers and cord wood a system of cutting similar to that above described might be adopted, with a lower size limit for the reserves, say 10 inches on the stump or under certain circumstances 8 inches.

PUBLIC SENTIMENT.

The character of the investigation was such that the writer was brought into contact with a very large number of the residents of the Black Hills. Special point was made to talk with these men in regard to the question of the forest reservation and to learn their opinions about it. In nearly every case, as soon as people found that there is no intention to defraud them of their homes or privileges, to prevent farming or prospecting, and that the prime object of the reservation is to prevent waste, to control the use of timber, and to protect public and private property from fires, there was an entire change of opinion, and a desire was expressed to aid in bringing about such a system. A system of management which will provide forest protection, and will not deprive the settler of his rights and privileges, will not be opposed by the people. Any system which cuts down the amount of tillable land in the ranches will be bitterly fought. Under the present system the ranches have been taken up as placer claims. As a rule, one man secures seven other names, and, each taking up 20 acres, a ranch of 160 acres is staked out. In this way long strips of agricultural land are taken by one man. If, under the new system, it is necessary for the rancher to obtain title to his land in 40-acre plots, it is manifest that the amount of tillable land on each ranch will be reduced. In such case the reservation will meet opposition from all ranchers. For the most part the lumbermen will not oppose the reservation, provided they can obtain timber for a reasonable stumpage price—say $1 on the stump—but they are desirous of having a settled system for obtaining timber. Miners will not oppose the reservation if prospecting is permitted and they are allowed timber for developing the mines.

It may be said that nearly all the residents are in favor of protection against fire and of some control of cutting, and if the reservation does not deprive the ranchers of a part of their cultivable land it will not meet with serious opposition.

DETAILED FOREST DESCRIPTIONS.

For convenience in describing the forest the entire area was divided into regions and these subdivided into districts. Each region covers the area drained by some important stream. The districts were made to include as large an area as could be conveniently described, and are much larger where the conditions are uniform, as on the cut-over areas in the northern hills or the untouched regions in Wyoming, than where the conditions in each valley or canyon differ, as in the eastern central hills. The boundary lines of the districts are ridges and streams.

BEAVER CREEK.

Beaver Creek is formed by a number of branches, which head in the southeastern portion of the hills, and, uniting in the plains, empty into the Cheyenne River. The north branches head among the quartzite ridges south of French Creek. Here the country is characterized by high ridges broken by narrow valleys, which have been cut out of the soft schists by the streams. The south branch heads in a nearly level country immediately south of Custer. It has at first a southern course, and, turning eastward at Rocks, meets the other branches below the timber. Cold Brook, which, together with Lame Johnny, is included in this section, rises in the same level country as South Beaver. It runs at first parallel with the latter and below Rocks swings to the southeast and enters a deep canyon, which continues to within a few miles of Hot Springs. A short distance below Rocks these streams cut through the limestone.

A larger portion of this district has been lumbered than any other in the southern hills. There are now but a few untouched bodies of timber and these are being rapidly cut. In the rugged mountains north of Rocks there is still considerable timber, which has been somewhat difficult of access and for this reason left till the present time. This timber averages 18 inches in diameter, and in the ravines and narrow valleys is tall and clear. On the ridges it is light and somewhat stunted. This forest has a density of 0.6. Fire has injured the old trees to a certain extent, but as a rule they have remained remarkably sound. This timber will average about 2,500 feet per acre. West of Mayo there is a body of timber, which is being cut by Bailey & Chapman, estimated at about 1,500,000 board feet. The forest which remains after lumbering is chiefly composed of scrubby and defective trees and such as were too small for lumber. It is estimated that there are about 10 cords per acre left on the cut-over lands. There are, however, occasional trees left which are now suitable for lumber. These trees are scattered, and over the whole area would not amount to over 5,000,000 board feet. In the lower part of the region, near the edge of the timber line, there are large open parks and, on the flat limestone plateaus, extensive prairies. The forest in the canyons at the southern edge of the main body of timber is mostly young growth, about 40 years old. Here and there are straggling scrubby trees, but in most places even trees of this character have been removed by the ranchers in the plains.

There are approximately 104.9 square miles covered with timber in this section. It is estimated that the total yield in lumber is 23,000,000 board feet and in other timber 800,000 cords. The following measurements were taken in this district:

Sample plots studied in Beaver Creek region.

No.	Merchantable trees.		Stumps after lumbering.		Other trees.		Board feet.	Cord wood.	Tops.	Dead trees.		Area.	Place.	Density.
	Number.	Average diameter.	Number.	Average diameter.	Number.	Average diameter.				Number.	Cords.			
		In.		*In.*		*In.*		*Cords.*	*Cords.*			*Acres.*		
39	1	20	0	0	23	12	250	5.0	0.4	3	0.8	½	Bakerville.	0.4
40	4	23	0	0	3	17	1,200*a*	1.5	2.0	0	0.0	½	Pringle	0.4
41	0	0	12	17	16	16	2,400	6.0	3.5	0	0.0	½	....do...	0.4
42	0	0	10	17	25	16	2,000*a*	10.0	3.0	0	0.0	½	Mayo...	0.4
83	0	0	2	23	37	12	700*a*	7.0	0.0	2	.....	½	....do...	......
84	0	0	0	0	12	13	0	3.0	0.0	0	.....	½	....do...	......

a Removed by the lumbermen.

The reproduction is locally very fine, especially west of Mayo. Near the parks and prairies, however, reproduction is slow. The average density of the whole forest is 0.4. The forest has suffered severely from fires. The trees are badly scarred at the butt, and the forest is rather broken and open, especially at the lower part of the region. In 1895 a great fire burned over a large area northwest of Mayo, killing all the timber in its main track. There were severe fires south of Pringle in 1893 and 1894.

Within the timber district there are 40 to 50 ranches, not counting those at the edge of the plains. The products are chiefly oats, potatoes, and hay.

District No. 1.—Lame Johnny.

Rock ....Chiefly quartzite and schist

Soil ....On bottom lands a deep, strong loam; on slopes thin and stony.

Litter................Thin.

Humus................1 to 2 inches.

Forest ....For the most part an open stand of rather scrubby pine, about 16 to 18 inches in diameter and 60 to 70 feet high, with a clear length of 20 to 25 feet, mixed with scattered second growth of inferior quality.

Density ....0.5.

Reproduction.......At western part good; near timber line very poor.

Cutting ....Practically the entire district has been lumbered to supply Buffalo Gap; all the best lumber removed. What remains is of inferior quality.

Yield.................About 300 feet per acre; cord wood, 8 to 10 cords per acre.

FIRE.................Large percentage of old trees injured by ancient fires. Fire in 1896 destroyed a large tract of timber at western part of district.

TRANSPORTATION.....All timber accessible to existing roads.

DISTRICT No. 2.—BAKERVILLE.

ROCK.................Quartzite, quartz, schist.

SOIL..................As in preceding.

LITTER................Thin.

HUMUS...............1 to 2 inches.

FOREST...............At western portion, in ravines, an original forest of pine about 18 inches in diameter and 60 to 70 feet high, with a clear length of 25 to 35 feet. On ridges and slopes timber is lighter, about 15 inches through on an average. At lower end of district the forest is composed of scrubby pine, left after lumbering the area, mixed with inferior second growth.

DENSITY.............At lower portion, 0.4; on western section, 0.6.

REPRODUCTION.......For most part poor.

CUTTING.............Lower portion practically all culled of merchantable saw lumber; chiefly cut for Buffalo Gap.

YIELD.................About 2,500 feet per acre in untouched portion of the district; elsewhere 100 to 300 feet per acre; cord wood, 8 to 10 cords per acre.

TRANSPORTATION.....Practically all timber accessible to existing roads.

DISTRICT No. 3.—BEAVER CREEK.

ROCK.................At upper portion granite, schist, and quartz; at lower portion limestone.

SOIL..................A fresh, deep, productive loam, except on steep slopes, where the soil is thin and stony.

LITTER................Medium in dense stands; elsewhere soil grassed over.

HUMUS...............1 to 3 inches.

FOREST...............For the most part a broken stand of scrubby and defective or small trees remaining after cutting, mixed with patches of second growth about 40 years old; small tract of unlumbered timber 16 to 18 inches in diameter on an average and 60 to 70 feet high, with clear length of 20 to 30 feet. Aspen, birch, and willow occur in ravines.

DENSITY.............0.5.

REPRODUCTION.......Above Mayo excellent; at lower end extremely poor.

CUTTING.............All cut over, except southeast of Mayo, within last six years.

YIELD.................On untouched tract 2,500 board feet per acre; elsewhere about 300 feet per acre; cord wood, about 10 to 15 cords per acre.

FIRE.................Large tract of cut-over land west of Mayo stripped by fire two years ago.

DISTRICT No. 4.—ANTELOPE SPRINGS CANYON.

ROCK.................Limestone.

SOIL..................Thin, calcareous clay on plateaus; in bottoms rich earthy soil.

LITTER AND HUMUS..Soil mostly grassed over.

FOREST ....Chiefly an irregular second growth of 40-year-old saplings; formerly considerable merchantable timber in deep canyon, but has been mostly removed; some scrubby trees left; most flat ridges and plateaus open prairies; timber confined to ravines and canyons.
REPRODUCTION.......Poor.
CUTTING ....Nearly all saw lumber removed within last ten years.

DISTRICT NO. 5.—HEAD ANTELOPE SPRINGS CREEK.

ROCK ....Granite, schist, and quartz.
SOIL ....A fairly deep, productive loam; on steep slopes thin and stony.
LITTER................Medium.
HUMUS ....1 to 2 inches; near parks ground grassed over.
FOREST ....Chiefly rather scrubby trees, 16 to 18 inches in diameter and about 60 feet high, left after cutting the area for lumber; clear length about 20 to 30 feet. A small amount of untouched timber near Bailey & Chapman's mill.
DENSITY ....0.5 to 0.6.
REPRODUCTION.......Moderate.
CUTTING ....Cut over for lumber during last six years.
YIELD.................300 to 500 board feet per acre, left by lumbermen; other material, about 10 cords per acre on an average.
FIRE..................Severe fire in 1895, which killed a large amount of timber in the northern portion.
TRANSPORTATION ....District well covered with roads; all timber accessible.

PLEASANT VALLEY.

This region embraces an area of 64.8 square miles. It comprises the drainage area of Red Canyon Creek, which is dry during the greater part of the year. The head branches rise in schist formation near the head of French Creek, but the greater portion of the district is in limestone. The main branch runs through a broad, open valley, which would be very productive were it possible to secure water for irrigation. West of the valley there are broad, high, limestone plateaus, which in the southern portion have been stripped of their forest covering by severe fires. Below the point where the various branches come together the stream enters a narrow canyon, called Red Canyon, with steep slopes rising 300 to 400 feet on each side.

At the head of Lightning Creek, one of the western branches of Pleasant Valley, there is a body of the finest timber in the southern hills. East and south of Lightning Creek there is almost no merchantable timber left. There is said to be a small body left between Mayo and Pleasant Valley, but the greater portion of the lumber has been removed. What is left was considered at the time of cutting too small or scrubby for the mill. A large number of trees were left, however, which will make lumber, and doubtless the area will be again cut over when the timber becomes scarce farther north. It is estimated that there are about 300 feet per acre left on the lumbered tracts. The lower part of the region is for the most part prairie and park land, and what timber occurs is only about 40 years old. The forest may be described in general as composed of rather scrubby trees 16 inches in diameter and about 60 feet high, broken by patches of second growth about 40 years old. At the lower end the forest is confined to the slopes of the ravines and canyons, and the flat limestone plateaus and ridges are prairies covered with a thick growth of grass.

It is estimated that 6,632 acres will yield about 4,000 feet per acre, 8,472 acres 1,000 feet per acre, and 26,368 acres 300 feet per acre. This makes the total yield of saw lumber about 40,000,000 board feet. The rest of the growing stock is placed at 400,000 cords.

The density of the forest is low, on account of the naturally open condition and also on account of lumbering. The density is estimated as 0.5, not including the parks and prairies.

The following sample plots were studied in this region:

Sample plots studied in Pleasant Valley region.

No.	Merchantable trees.		Stumps after lumbering.		Other trees.		Board-feet.	Cord-wood.	Tops.	Dead trees.		Area.	Place.	Density.
	Number.	Average diameter.	Number.	Average diameter.	Number.	Average diameter.				Number.	Cords.			
		Ins.		*Ins.*		*Ins.*		*Cds.*	*Cds.*			*Acre.*		
43	4	25	0	0	1	8	1,500	.....	2	0	0	½	Pleasant Valley	0.2
44	11	17	0	0	12	10	2,200	1.5	1	0	0	½	do	0.4
46	13	16	0	0	26	12	2,000	5.0	3	0	0	½	Lightning Creek.	0.5

There are, approximately, 41.2 square miles which have been lumbered. This timber has been cut chiefly within the last six years. Reder & Tipton cut over a large section in the northern part of the district, and J. C. Merrick, who is now operating at the head of Lightning Creek, lumbered in Pleasant Valley in 1895 and 1896. There is one other mill operating within the district, owned by Thomas Mullen, on Lightning Creek.

There are within the region 15 to 20 ranches, of which 5 are deserted. These 5 ranches are situated between Fourmile and Eighteenmile, and were deserted on account of lack of water. At Fourmile there are two stamp mills, neither of which is running. Mining within this section is not extensive, and is chiefly confined to developing and assessment work. The southern portion of the district is used for grazing purposes.

DISTRICT No. 6.

ROCK .... Chiefly limestone.
SOIL .... Calcareous clay.
HUMUS and LITTER ... Thin.
FOREST .... For the most part culled of merchantable saw lumber. What remains is chiefly rather scrubby, defective, or small trees about 15 inches in diameter, on an average. On many slopes a forest of poles about 12 to 16 inches in diameter, with an apparent age of about 150 years. At lower end the timber is very coarse, with a large amount of young sapling growth about 40 years old.
DENSITY .... 0. 5.
REPRODUCTION ...... Good at upper portion; poor near timber line.
CUTTING .... Greater part of the best saw lumber removed within the last six years.
YIELD .... About 300 feet per acre; other material, 8 to 10 cords per acre.

DISTRICT No. 7.—LIGHTNING CREEK.

ROCK .... At upper end granite and schist; at lower end chiefly limestone.
SOIL .... On bottom lands rich deep loam.
LITTER .... Thin.
HUMUS .... Half inch.
FOREST .... At head of creek excellent original forest, with trees averaging 20 inches in diameter and about 70 to 75 feet high, with long clear stems, mixed with considerable young growth, apparently about 50 years old. On southern portion a somewhat irregular forest of veterans, averaging 20 inches in diameter, of which a large percentage are defective, mixed with large poles, apparently about 160 years old, and saplings about 40 years old. Northeastern section culled of merchantable timber.
DENSITY .... 0.5 to 0.6.
REPRODUCTION .... At head of creek excellent; at southern end poor.
YIELD .... Head Lightning Creek, 4,000 feet per acre; on other uncut land, 1,000 feet per acre; on cut-over land, about 300 feet per acre. Of other material, 10 to 15 cords per acre.
TRANSPORTATION ..... Nearly all timber accessible to existing roads.

DISTRICT No. 8.—LEIGHTON CREEK.

ROCK .... Chiefly limestone.
SOIL .... Rather compact calcareous clay.
HUMUS and LITTER ... Large part of area grassed over.
FOREST .... In northern section a somewhat irregular forest of veterans, averaging about 20 inches in diameter, of which a large percentage are defective, mixed with poles not yet large enough for lumber and saplings about 40 years old. At southern end the forest is chiefly composed of second-growth saplings, interrupted by large, open parks.
DENSITY .... 0.5 to 0.6, including large openings.

REPRODUCTION.......Poor.
YIELD................In northern portion, 1,000 feet per acre; cord wood, 8 to 10 cords per acre.
TRANSPORTATION.....Roads crossing the northwestern corner. Roads can without difficulty be built to reach the merchantable timber.

DISTRICT NO. 9.—RED CANYON.

ROCK ....Limestone.
FOREST ....Confined to ravines and canyons; flat ridges are grassed prairies; trees chiefly second growth, about 40 to 50 years old.

HELL CANYON.

This district drains the southwestern portion of the Black Hills, and includes within the timber limits an area of 81.8 square miles. The region is dry during the greater part of the year. The northern portion of the district is characterized by limestone plateaus, broken by small swales, which form open grassy parks. Below the union of the various branches the main canyon begins with abrupt walls rising 400 to 500 feet on each side. The canyon bottom is flat, several hundred feet wide, and covered with a dense growth of grass, making excellent grazing land. On each side of the canyon are high plateaus, broken by the ravines and gulches which run into the main gorge. The entire district is within the limestone formation. Within this district are included three branches, which meet Hell Canyon near the point where the stream cuts through the Elk Mountain Range. These branches are West Hell and Tepee canyons and Pass Creek. Like Hell Canyon, they are dry except for occasional springs near their headwaters.

The lower part of the canyons are almost entirely devoid of tree vegetation, except a few straggling specimens on the sides of some ravines. North of the point where the L. A. K. road crosses the canyon there is a solid body of timber which is broken only by narrow parks or occasional burnt, flat ridges. This forest consists of old trees, 18 to 20 inches in diameter and of medium height, interspersed with smaller and younger trees about 12 to 14 inches in diameter. Within the canyons and ravines the timber is very tall and clear and fairly sound. Below the L. A. K. road the timber is confined to the narrow ravines and canyons. The ridges are almost in every case bare and grassed over, and a few miles below the L. A. K. road the old timber practically runs out and the forest is composed of young saplings about 40 years old. East of Hell Canyon there is a considerable body of timber of merchantable character in the narrow ravines which drain directly into the main canyon and on the lower slopes skirting the parks. This timber has a yield of 1,000 to 1,500 feet per acre. There is a body of timber of similar character at the head of Tepee Canyon, and at the head of Pass Creek there is some merchantable timber within the narrow ravines. It is estimated that at the head of the canyon there are about 50,000 acres, with a yield of 1,000 feet of saw lumber per acre, and about 3,000 acres yielding 2,500 feet per acre. Besides this saw lumber there are a large number of young poles not yet large enough for lumber. It is estimated that the total standing crop of timber not classified as saw lumber is 800,000 cords. Within this region is included the Elk Mountain ridge, which is timbered to its base. On Elk Mountain itself the timber is about 15 inches in diameter on an average and about 50 feet high, mixed with second-growth saplings. The rest of the ridge is covered with scattered, scrubby trees.

Sample plots studied in and near Hell Canyon.

No.	Merchantable trees.		Other trees.		Board feet.	Cord wood.	Tops.	Dead trees.		Area.	Place.	Density.
	Number.	Average diameter.	Number.	Average diameter.				Number.	Cords.			
		In.		*In.*		*Cords.*	*Cords.*			*Acres.*		
79	6	20	14	18	1,500	7.5	2.0	2	1.0	½	Hell Canyon.	0.5
80	6	21	32	16	1,500	12.5	2.0	3	0.6	½	....do	0.4
81	7	15	35	11	700	5.5	1.0	0	0.0	½	....do	0.5
82	2	15	18	12	200	3.0	0.3	2	0.7	½	....do	0.3

The reproduction in this region is rather poor, chiefly because it has been so badly burned that the ground is everywhere covered with a compact sod, which is a great hindrance to reforestation. The forest, however, is creeping outward, as is shown by the mass of young timber coming up on the slopes at the edge of the timber line.

Probably a large portion of what is now prairie was once covered with trees, which have been destroyed by fire and prevented from returning on account of the condition of the soil and the recurring fires. If fires are kept out, doubtless much of the natural forest land will again be reseeded to pine. It is said there were severe fires in this section in 1888 and 1890.

Stock raising is the only industry in this region. There are 11 ranches in the entire timbered district. Agricultural land is very limited, because of the lack of water. If it were possible to irrigate, crops could be raised on much of the land in the bottoms of the ravines and canyons. There has been no lumbering in this region on account of its distance from market.

DISTRICT NO. 10.—PASS CREEK.

ROCK ....Limestone.
SOIL ....Rather compact calcareous clay.
HUMUS and LITTER...Thin. Over most of district soil is grassed over.
FOREST ....At head of creek an irregular forest of old trees about 16 to 18 inches in diameter. Many trees are rather scrubby. Best timber confined to narrow canyons. High flat ridges open and grassed over. In less rugged country, below Olsen's ranch, forest chiefly young sapling growth, about 40 to 50 years old. On high ridges in southwestern part of district there is an open forest of scrubby old trees, about 15 inches in diameter, mixed with second growth.
DENSITY ....At head of creek in forest limits, 0.5; below Olsen's, 0.3 to 0.4.
REPRODUCTION ......Poor, except at very head of creek, where it is moderate.
YIELD ....At head of creek, 1,000 to 1,500 board feet per acre.

DISTRICT NO. 11.—HELL CANYON.

ROCK ....Limestone.
SOIL ....Dry, rather compact calcareous clay; mostly grassed over except at head of creek.
FOREST ....At northern end, a forest of poles 10 to 14 inches in diameter, mixed with old trees about 18 inches in diameter and interrupted by open parks. In the canyons of the central portion, timber about 18 to 20 inches in diameter and about 60 to 70 feet high, with stems clear about 30 feet. Many large open plots on flat ridges and on broad canyon bottoms. Below Water Gulch, trees very scrubby and in large part saplings about 40 years old, confined to narrow ravines and slopes. Extreme southern section is prairie.
DENSITY ....In northern portion, 0.6 to 0.7; central portion, about 0.6; below Water Gulch, 0.4. This does not include prairies.
REPRODUCTION.......Poor.
YIELD.................In some of the side gulches in central portion, 2,500 feet per acre; elsewhere in old forest, 1,000 feet per acre.

DISTRICT NO. 12.—TEPEE CANYON.

ROCK ....Limestone.
SOIL ....Dry, rather compact calcareous clay; mostly covered with compact sod of grass.
FOREST ....At extreme head of creek the forest is similar in character to the central portion of Hell Canyon; below L. A. K. road composed chiefly of saplings about 40 years old, confined to slopes and narrow canyons. Greater part of district is open prairie. Elk Mountain is covered to its base with a fairly dense growth of timber about 15 inches in diameter, mixed with second growth of various ages. On ridges south of Elk Mountain timber is scattered and scrubby.
DENSITY ....0.5 on Elk Mountain and head of Tepee; 0.4 below L. A. K. road.
REPRODUCTION.......Poor, except on top of Elk Mountain.
CUTTING ....Lumber and ties were cut on Elk Mountain when railroad was built to Billings, Wyoming.
YIELD.................At head of Tepee, 1,000 feet per acre.

RED BIRD CREEK.

This region comprises the district west of Hell Canyon and includes the area drained by Red Bird or Hay Creek and the Buck Springs and Gillette canyons. The creek heads high in the Limestone Divide, at an elevation of nearly7,000 feet, and has a northerly course. The creeks are dry during most of the year, and usually such springs as are found scattered through the region are taken up by ranchers. The valleys and ravines are all open grassed parks, with soil rich enough to produce heavy crops if water could be obtained. At the head of the district there are some patches of spruce. The timber in this portion is small and chiefly a second growth. A few miles north of Preacher Springs there are found, mixed with the second-growth timber, old trees, which are usually badly scarred by fire and in many places are dying. There is often 25 to 30 per cent of the old timber already dead. It is, as a rule, short and full crowned, and appears like timber which has come up on a large burn and, in the second generation, has seeded up the area to a full crop of trees. The second growth has an apparent age of 100 years and is 10 to 14 inches in diameter. In Gillette Canyon the timber is of somewhat better quality. Below Buck Springs the timber begins to run out and is confined to the slopes and canyons, nearly all flat plateaus being grassy prairies. The average density of the forest is 0.6.

It is estimated that 100 square miles in this district are covered with timber. Of this, one-third will yield 1,000 feet per acre, and two-thirds 500 feet per acre. The rest does not bear merchantable saw lumber, but the trees are large enough for hewn timber. The total yield in saw lumber is estimated at about 34,000,000 board feet, and in other timber 900,000 cords. There is at present no market for forest products.

There are about 12 ranches in this district, including those which have been taken up during the present year. The ranchers own a considerable number of stock, which find excellent grazing throughout the district.

DISTRICT NO. 13.—GILLETTE CANYON.

ROCK ....Limestone.
SOIL ....Calcareous clay; rather compact; dry.
HUMUS and LITTER...Light. Large portion of area grassed over.
FOREST ....A mixture of old timber about 18 inches in diameter and 60 to 70 feet high, with a clear length of 15 to 30 feet, and second-growth poles which have an apparent age of about 100 years, and saplings about 40 years old. A large proportion of old trees show injury by fire at the butt. Many high flats open and covered with a thick sod of grass. At edge of timber line trees coarse and scrubby.
DENSITY ....0.5 to 0.6.
REPRODUCTION.......Poor; best on north slopes.
DEAD TIMBER ....5 to 10 per cent.

FIRE ....Forest badly injured by old fires; one large mass of dead timber covering several hundred acres.
YIELD ....About 1,000 to 1,500 board feet per acre; other material, 10 to 15 cords per acre.

DISTRICT NO. 14.—RED BIRD CREEK.

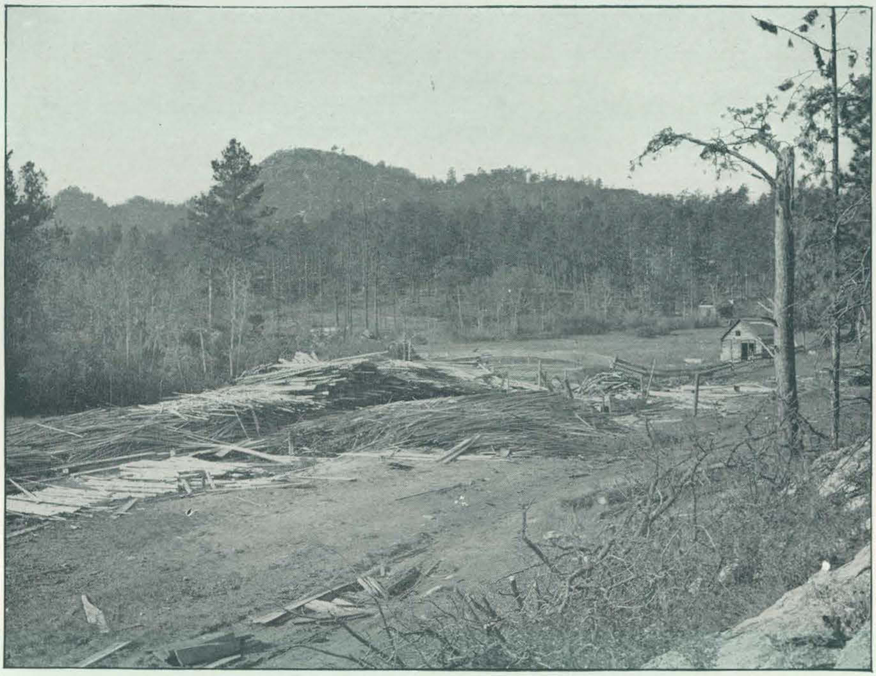
ROCK ....Limestone for most part.
SOIL ....Calcareous clay, rather compact and dry.
HUMUS and LITTER...In dense forest at upper end fairly thick. Ground at lower end mostly covered with grass.
FOREST ....At upper end of district chiefly second-growth poles about 12 to 14 inches in diameter, mixed with scattered old timber about 18 inches in diameter, mostly full crowned and rather short bodied, interspersed with numerous parks. Old timber severely injured by fire and consequently very defective. At lower end timber scattered and of inferior quality and about 75 per cent of trees burned at butt. At upper end large amount of aspen on burns; at lower portion red cedar found on brakes.
DENSITY ....0. 6.
REPRODUCTION.......Poor.
DEAD TIMBER ....About 10 per cent of old timber.
YIELD ....On better portions, 1,000 feet per acre; elsewhere in old forest, 500 feet per acre. Other material, 10 to 15 cords per acre.
TRANSPORTATION.....Road through entire district. Timber not difficult of access, but there is no market for it at present.

DISTRICT NO. 15.—PREACHER SPRINGS.

ROCK ....Chiefly limestone.
SOIL ....Strong, compact, but rather dry clay.
HUMUS and LITTER...In dense second-growth forest thick.
FOREST ....A forest of poles 12 to 14 inches in diameter, with a large number of old trees about 18 to 20 inches in diameter, interspersed with numerous parks. Small timber about 100 years old; rather knotty. Old timber short bodied, broad crowned; many trees fire scarred and defective. On burned areas much small aspen.
DENSITY ....0.6.
REPRODUCTION.......Poor.
DEAD OLD TIMBER ...10 per cent.
YIELD ....About 1,000 feet per acre. Small trees, 10 to 15 cords per acre.

FRENCH CREEK.

French Creek is formed by numerous small streams, which rise in a region where schist is the prevailing rock, and flow through a comparatively level and rolling country, forming broad open parks, with rich, deep, productive soil. The various branches meet near the present site of Custer, and, a few miles below, the main stream enters a narrow valley, with high, rugged quartzite and granite ridges on each side. The region includes the southern slopes of the Harney Peak Range. This is a very rugged mountainous section, with broken granite ridges and divides, separated by rich, narrow valleys, where



A. AN OLD SAWMILL NEAR CUSTER, SOUTH DAKOTA.

B. A LUMBERED TRACT ON FRENCH CREEK, SOUTH DAKOTA.

the streams have eroded the easily disintegrated schist. The region becomes contracted at the lower part, where the stream flows through a deep gorge, with steep, abrupt slopes on each side. The bottom of the canyon forms a flat, several hundred feet in width, with rich soil in some places, and elsewhere covered with coarse gravel and rocks washed down by the stream.

The ridges are granite and quartzite, and the steep slopes are covered with angular rocks and coarse gravel. The stream is intermittent and there are frequent stretches of slack water.

This region was formerly covered with a fine forest of old timber about 20 inches in diameter and 75 to 80 feet in height. It was interrupted by the large Custer Prairie and the numerous parks which follow the streams. The timber was easily accessible in the comparatively flat country, and when the railroad was built a ready market was found, so that lumbering has formed one of the chief industries of the region. The greater part of the western section of the French Creek region has already been cut over for saw lumber. There still remains a body of fine timber at the very heads of the streams which form the main creek. Sawmills are pushing into this region as rapidly as possible, and would have cut it out still more were it not for the long distance which the lumber has to be hauled. There are here about 10,000 acres still untouched, with an estimated yield of 4,000 feet of saw lumber per acre.

There is a good body of timber at the head of Willow and Bismarck creeks at the foot of the divide south of Sylvan Lake, but most of the saw timber has been removed from the lower part of the creeks, except a small body which is being sawed into lumber by Bower & Clark, and small patches preserved on mineral claims. The forest has not been much cut for mine props, nor has green timber been cut for cord wood to any great extent. The forest has merely been thinned heavily, and not stripped, except in a few places where shingle mills have operated. The forest after lumbering is composed of large, defective, scrubby trees and small trees not large enough for saw lumber. There are usually as many trees left as have been taken, and often two and even three times as many. On an average there are in this region 10 to 15 cords of wood per acre left on the ground after cutting, not counting what is left in the tops. Of this a large amount could be used for mine props were there a market for such. There are, on an average, 8 to 10 trees per acre suitable for 11-inch flats and 15 which could be used for lagging. Much of the timber near Sylvan Lake is light—about 8 to 12 inches in diameter—but the forest is dense, and, if protected, will in time form excellent lumber.

One of the most noticeable features of this forest is the excellent reproduction. There are many places, especially near Custer Prairie, where the ground has become grassed over and the reproduction is poor, but as a rule the young growth springs up readily and in dense thickets. The young growth on Willow Creek is particularly good.

At high elevations and in moist ravines spruce of rather small size, aspen, and white birch are very abundant.

Below Custer Prairie, where the main canyon begins, the timber has not been so much cut. Considerable bodies have been held by owners of claims, but at present much of this is being sold to lumbermen. There is still a large amount of heavy timber in the ravines back in the mountains, and below the point where the road leaves the creek there is a large body of timber in the main canyon. The old timber averages 20 inches in diameter and is 75 to 80 feet in height, with a clear length of about one-half the length of the tree. This old timber is found in the gulches and at the heads of the side ravines. In places it runs well up on the slopes, and in some cases even to the top of the divide. On Lower French Creek the old timber is scattered along the canyon bottom and has a density of about 0.5. The density of the whole Lower French Creek region is fully 0.6. The region has at different periods been badly injured by fire, especially on the slopes and ridges, but the old timber in the bottoms of the canyon has escaped to a large degree. The timber on the slopes is light, having a diameter of about 12 to 14 inches on the stump. It is badly fire scarred, and is of extremely slow growth. This small timber is tall and clear boled, and would make excellent mine props. There are occasional patches of old trees at the heads of the various ravines, but they are usually defective on account of the severe fires. Pl. XXII, *A*, gives a good idea of this forest. In the canyon there is a thick jungle of birch, aspen, and willow, and at the lower end ironwood, elm, and oak, besides such shrubs as nine-bark, elder, dogwood, etc.

The following valuation surveys were taken in different parts of the region and furnish a more distinct picture of the forest than can be given in words:

Sample plots studied in French Creek region.

No.	Merchantable trees.		Stumps after lumbering.		Other trees.		Board feet.
	Number.	Average diameter.	Number.	Average diameter.	Number.	Average diameter.	
		Inches.		*Inches.*		*Inches.*	
35	3	18	0	0	29	12	700
36	10	20	0	0	21	15	2,500
37	14	20	0	0	20	20	3,500
38	0	0	11	19	26	12	*a* 2,400
47	9	15	0	0	33	10	900
83	0	0	2	23	37	12	*a* 700
84	0	0	0	0	12	13	0
85	9	20	0	0	16	13	2,300
86	15	19	0	0	22	13	3,700
87	8	18	0	0	32	14	1,800

a Taken by the lumbermen.

A. GOOD REGROWTH, AFTER LUMBERING AND FIRE, ON FRENCH CREEK, SOUTH DAKOTA.

B. A SAWDUST HEAP ON FIRE 3 MILES EAST OF CUSTER, SOUTH DAKOTA.

Sample plots studied in French Creek region—Continued.

Cord wood.	Tops.	Dead trees.			Area.	Place.	Density.
		Number.	Average diameter.	Cords.			
Cords.	*Cords.*		*Inches.*		*Acre.*		
6	1.0	1	14	0.3	½	Lower French Creek.	0.5
7	3.0	2	19	1.2	½		0.5
14	5.0	1	18	0.5	½	Willow Creek.	0.5
5	3.0	0	0	0.0	½	....do.....	0.5
4	1.5	0	0	0.0	½	North of Custer.	0.6
7	0.0	0	0	0.0	½	South of Custer.	0.4
3	0.0	0	0	0.0	½		0.3
4	3.0	0	0	0.0	½	Head of French Creek.	0.4
5	5.0	2	15	0.7	½		0.6
9	3.0	0	0	0.0	½		0.5

It is estimated that there are, altogether, 40,000,000 feet of merchantable timber at the head of French Creek, 6,000,000 feet at the heads of Willow and Bismarck creeks, 8,000,000 feet on Lower French Creek, and 8,000,000 feet scattered over the divides and in spots left by the lumbermen. This makes a total of 62,000,000 feet, of which 75 per cent is accessible. There is a total of about 900,000 cords of standing wood besides this amount.

As elsewhere in the Black Hills, the forest shows the effect of old fires. This is particularly the case on Lower French Creek, where the ridges everywhere are covered with fire-scarred trees. The presence of the large number of parks and the prairie, and the wounds at the foot of the trees, are evidences of the great damage by ancient fires. The bodies of second growth, on the divide near Sylvan Lake and on Willow Creek, bear witness to the same fact. The actual injury to the timber has been very great, and probably fully 30 per cent of the trees now standing have received some injury by fire. Of recent fires, that which occurred in 1896 has done the most damage. It burned over several hundred acres south of the creek and west of the Bellmore ranch. This fire killed every tree in its path.

It is estimated that 62 square miles of the French Creek district has been cut over for lumber. This work has been done by a number of sawmills, which have moved from one place to another as fast as the timber was cut and sawed. The chief lumber operators have been Odo Reder, J. F. Durst, A. Gates, Lee Shepherd, M. J. Bailey, E. C. Chapman, M. A. Tipton, John Bostwick, Bower & Clark, Thomas Mullen, O. H. Merrick, C. E. Boyden, E. D. Greathouse, and A. Rice. There are at present 6 sawmills in operation within the French Creek district—J. F. Durst and A. Gates, on Lower French Creek; Odo Reder, at the head of the Middle Fork; John Bostwick, at Custer; Bower & Clark, on Willow Creek, and Lee Shepherd, southeast of Custer. Ties were cut for the railroad at the time it was built, but the larger amount of lumber has been cut since that time.

The industries of the region are mining, lumbering, farming, and stock raising. Compared with the northern hills, mining can not be said to be an important industry in this section. There are many men living within the district who spend their time prospecting, and throughout the region are seen test pits and quartz blow-outs, but the mines which are actually operated further than doing merely the annual assessment work are few. There are several mica mines, of which one is being worked; and there is one dredge placer mine west of Custer.

Throughout the western portion of the French Creek district there are numerous ranches scattered along the parks through which the branches of the creek flow. The soil is a rich loam and is exceedingly productive, and much of the land now used for grazing would be very productive were it possible to secure water for irrigation. There are between 25 and 30 ranches within the district. The chief products are oats, potatoes, and hay.

There is a considerable amount of stock, which ranges over Custer Prairie and through the open forests in that vicinity. This stock is owned mostly by ranchers, and, comparatively speaking, stock raising can scarcely be called an industry of any importance in this district.

District No. 16.—Head of French Creek.

Rock ....Granite, schist, quartz.
Soil ....Fairly deep loam on bottom lands; on slopes, gravel.
Humus................One-half inch. Considerable areas grassed over.
Forest ....At extreme western end, an unlumbered forest of veterans, averaging 20 inches in diameter and 70 to 80 feet high, with a clear length of about 25 to 35 feet, mixed with second-growth low poles about 50 to 60 years old. At eastern end, best lumber removed.
Density ....0. 5 to 0. 6.
Reproduction ....Very good except near parks.
Dead timber ....3 to 5 per cent.
Cutting ....Entire area culled of choice saw logs, except at extreme western end. Two mills in operation.
Yield................In original forest, 4,000 feet per acre; elsewhere, 300 to 500 feet per acre. Cord wood, 10 to 15 cords per acre.
Transportation.....District well cut up with roads.

District No. 17.

Rock ....Quartzite, schist, quartz.
Soil ....Rich loam on bottom lands; on slopes, thin and stony.
Humus and litter...Thin.

FOREST .... Veteran forest of pine reaching a maximum diameter of 2½ feet, but for most part culled of choice merchantable timber; some untouched forest at southern extremity of district in ravines; on ridges timber light and in many places scrubby.

DENSITY .... 0.6.

REPRODUCTION .... Very good.

CUTTING .... 75 per cent saw lumber removed; 2 mills in operation.

YIELD .... In untouched timber, 2,500 feet per acre; elsewhere, 100 to 500 feet; cord wood, 10 to 15 cords per acres.

FIRE .... Trees badly scarred by old fires. Large area burned in 1896 and all timber killed in track of fire.

TRANSPORTATION ..... Good system of roads.

DISTRICT NO. 18.—LOWER FRENCH CREEK.

ROCK .... Quartzite, granite, schist, quartz.

SOIL .... On slopes, stony and thin; in ravines, rich loam.

HUMUS and LITTER .. Thin on slopes; heavy within canyon.

FOREST .... In canyon, a body of heavy timber averaging 20 to 22 inches in diameter, 75 to 80 feet high, with clear stems of 25 to 40 feet; on slopes, forest of poles 10 to 14 inches through, with long clear boles, mixed with scattered unsound veterans; some aspen and birch in canyon, and at lower end oak, elm, ironwood, and shrubs.

DENSITY .... 0.6.

REPRODUCTION .... Fair.

DEAD TIMBER .... 3 to 5 per cent.

CUTTING .... At upper end of canyon saw lumber removed by Durst, at central portion by Gates; 75 per cent of saw lumber cut.

YIELD .... In best portions, 5,000 feet per acre; at upper end, 3,000 to 4,000 feet per acre; of cord wood, 10 to 15 cords per acre.

TRANSPORTATION ..... Large part of timber very difficult of access.

DISTRICT NO. 19.—WILLOW CREEK.

ROCK .... Granite, schist, quartz.

SOIL .... On steep slopes, stony; on ravine bottoms, fresh productive loam.

HUMUS .... Half inch.

FOREST .... Greater part of the area culled of best timber. What remains is scrubby or defective trees, about 18 to 20 inches in diameter, mixed with second growth of various age. At head of Willow and Bismarck is a body of untouched timber 20 to 22 inches in diameter, 70 to 80 feet high, with a clear length of 25 to 35 feet. Aspen and birch are abundant in most places, and in narrow valleys, and at high elevations small spruce is found in considerable quantities.

DENSITY .... 0.5.

REPRODUCTION .... Very good, except near open parks.

FIRE .... Large trees severely injured by old fires. Not less than 50 to 75 per cent of old trees show injury at butt.

CUTTING .... Fully 75 per cent saw lumber cut in lower portion of district.

YIELD .... At head of Willow and Bismarck creeks, 4,000 to 5,000 feet per acre; elsewhere, 200 to 300 feet per acre; cord wood, 10 to 12 cords per acre.

SQUAW CREEK.

This region comprises the watershed of three streams, Squaw, Little Squaw, and Spokane creeks, which together form the south fork of Battle Creek, meeting the north fork near Hermosa. These branches head at an elevation of 5,000 to 5,500 feet above sea level and have a fall of about 1,000 feet before emerging from the timber. The geological formation is partly granite and schist and partly quartzite. The slopes of the ridges are in many cases steep, often precipitous, and the soil is thin and covered with angular stones. Within the canyons and on the bottom lands and the lower gradual slopes the soil is fairly deep and fresh. It is a loam, mixed with sand or clay according as the formation is a granite or quartzite, or is schistose. Within the timbered portion of the region the valleys are narrow and do not open out until the point is reached where the timber disappears. The entire region comprises an area of 41 square miles and is almost entirely covered with forest. There are openings where the ranchers have cleared the land, and near the edge of the timber there are the characteristic parks and prairies. Elsewhere the area is covered with a solid body of timber varying in density, size, and quality. The region has been encroached upon by lumbermen comparatively little until recently. Along the creeks and on the bottoms of the valleys and ravines and on protected flats the timber is large, on an average about 20 inches in diameter, with a maximum diameter of 3 feet. The old timber is tall, with a height of 70 to 90 feet, with long clear boles, but is apt to be unsound. There are many trees about 160 years old, dating from the fire already mentioned several times. The old veteran trees are everywhere scarred by this fire, and doubtless in many cases the present unsound condition of the timber is due to severe burning. On the slopes and ridges the timber is light, averaging about 10 to 14 inches in diameter. In many places there are old veterans scattered among this younger crop, but they are usually unsound. This crop of poles is fairly dense, but, unfortunately, from the exposed situations on the slopes, the trees have been much injured by fires. In some cases the trees may heal over the wounds, but probably in the majority of cases they will become unsound. The total density of the forest is about 0.5.

Within the valleys and canyons there is a considerable amount of aspen of small size, which has come up after fires, and in the deep narrow ravines at the higher elevations, especially on Little Squaw Creek, there are numerous small spruces. Where the spruce runs out, burr oak begins, and along the bottoms of the ravines at the lower elevations there is a very large amount of small oak sprouts. There are occasional oaks 18 inches in diameter, but they are in all cases short and scrubby and the wood is said to be of inferior quality. Sometimes a tree is found large enough for one saw log. Pl. XXI shows a canyon bottom with a characteristic growth of aspen and a few young pine and oak sprouts. There are, besides the trees just mentioned, white birch, ironwood, and box elder. Among the shrubs which grow within this region are hazel, dogwood, nine-bark, Spiræa, snowberry, bearberry, wild rose, Shepherdia, and various Leguminosæ and other herbaceous plants which are found throughout pine forests. The second-growth timber is exceedingly free from undergrowth. The forest within this region reproduces itself with remarkable vigor, but on some ridges and hillsides, where the fires have been most severe and the soil is grassed over, the reproduction is poor.

The entire area has been severely burned. Most of the fires, however, date back many years, and the injury by recent fires is comparatively small. Fires of considerable extent burned over this region in 1888, 1889, and 1893. The direct injury by these recent fires has been chiefly confined to the destruction of young growth.

From the fact that a large portion of this area is rather inaccessible, the lumbermen have until lately cut but little timber. Near Spokane a sawmill owned by Cyrus Cole cut over a large area twelve years ago. In this same section the Hazeltine sawmill is now operating. Between Spokane and Little Squaw creeks there is a mill owned by Mr. Adams which is being worked irregularly, and there is a small water mill at Otis. The largest mill within the region is that owned by Mr. Boyden, near the head of Squaw Creek. This mill manufactures about 500,000 feet of lumber per annum. Altogether 9 square miles have been lumbered over in this region.

A number of sample plots were measured in this region and the measurements are given below:

Sample plots studied in Squaw Creek region.

No.	Merchantable trees. Number.	Merchantable trees. Average diameter.	Other trees. Number.	Other trees. Average diameter.	Board feet.	Cord wood.	Tops.	Dead trees. Number.	Dead trees. Cords.	Area.	Place.	Density.
		In.		*In.*		*Cords.*	*Cords.*			*Acre.*		
4	20	20	10	17	5,000	5.0	7.5	2	1.2	½	Squaw Cr.	0.5
5	18	17	11	12	4,000	2.5	6.0	0	0.0	½	....do	0.5
6	17	18	7	14	4,000	2.0	6.0	1	0.5	½	....do	0.5
7	11	19	15	13	2,800	3.5	4.0	1	0.4	½	....do	0.5
8	18	18	14	14	4,000	4.0	6.0	6	2.4	½	....do	0.5
9	15	18	14	13	3,500	3.5	5.0	0	0.0	½	....do	0.5

It is estimated that there are 1,900 acres with a yield of 6,000 feet of lumber per acre, 1,150 acres yielding 5,000 feet, and the rest 1,000 feet. Besides this amount there are about 10 to 15 cords per acre, and of this a large part may be used for props. The total stand of the whole region is estimated at 56,000,000 board feet of lumber and 400,000 cords of other timber.

The industries of the region are lumbering, mining, and agriculture. There are altogether 20 to 25 ranches scattered along the creeks. All rich bottom land is capable of cultivation and is exceedingly productive, but is for the most part in narrow strips and is at present covered with a more or less dense growth of timber and brush. Most of the mining is in the northern portion, near Bismuth and Spokane. There is a stamp mill at each place, but not now in operation. The forest is so dense that there is not much pasturage, and stock raising is confined to a few head of cattle or horses owned by the ranchers.

District No. 20.—Squaw Creek.

Rock .... Granite, schist, and quartzite.
Soil .... In bottoms, a fresh productive loam; on slopes, stony and gravelly.
Litter .... Medium.
Humus .... 1 to 2 inches.
Forest .... In ravines and canyons, a body of heavy timber reaching a diameter of 3 feet and a height of 90 feet, with long clear stems; on slopes and ridges, a forest of high poles 10 to 15 inches through and over 100 years old. Oak, aspen, birch, ironwood, etc., are abundant in ravines.
Density .... 0.6.
Reproduction .... Good for pine, except in narrow canyons and near timber line.
Dead timber .... About 4 to 5 per cent.
Cutting .... Two sawmills being operated—one at Otis, owned by Clason, the other at western end, owned by C. E. Boyden. About these mills the forest has been culled of merchantable saw timber. Density of forest not much affected.
Fire .... On ridges about 50 per cent of trees injured by old fires. Severe surface fires occurred in 1889 and 1893.
Yield .... In ravines, 5,000 feet per acre; elsewhere, 500 to 1,000 feet per acre. Other timber, 10 to 15 cords per acre.
Transportation .... One road through district. Nearly all timber accessible.

District No. 21.—Little Squaw Creek.

Rock .... Granite, schist, and quartzite.
Soil .... On bottom lands, sandy loam; on slopes and ridges, gravel; hillsides very stony.
Litter .... Good.
Humus .... 1 to 2 inches.
Forest .... In ravines an original forest of pine averaging 20 to 24 inches in diameter and 70 to 80 feet high, with a clear length of 25 to 30 feet; on ridges and slopes, timber about 15 inches in diameter, on an average, and in large part about 160 years old, mixed with younger poles 10 to 14 inches in diameter. In narrow canyons is found some small spruce, and below 5,000 feet elevation small scrubby oaks.
Density .... 0.6 to 0.7.
Reproduction .... Excellent in small openings.
Dead timber .... About 5 per cent.
Cutting .... Very light cutting near ranches, for local uses.

A. A SAWMILL COMMUNITY, OTIS, SOUTH DAKOTA.

B. WASTEFUL METHODS OF LUMBERING NEAR HILL CITY, SOUTH DAKOTA.

FIRE..................Many trees badly scarred by old fires. Large tract cleared on ridges by fire ten years ago and again four years ago.
YIELD.................On upper portion, 3,000 feet per acre; within small area in main valley, 5,000 feet per acre. Of defective, small, and scrubby trees, 10 to 15 cords per acre.
TRANSPORTATION.....Road through western portion of district. Timber in lower part of creek at present rather difficult of access

DISTRICT No. 22.—SPOKANE CREEK.

ROCK ....Granite, schist, and quartzite.
SOIL ....On bottom lands, a fresh sandy loam; on ridges and steep slopes, stony and thin.
LITTER................Excellent.
HUMUS ....1 to 2 inches.
FOREST ....At lower portion of district an open stand of rather scrubby pine, about 18 inches in diameter and 60 to 70 feet high, with a clear length of 15 to 25 feet; at upper part timber is denser, taller, and has a longer clear length. In ravines oak, as large as 20 inches, elm, and ironwood, are common.
DENSITY ....0.5 to 0.6.
REPRODUCTION.......Near Spokane very poor; at upper part of district excellent.
CUTTING ....Greater part of district has been cut over for lumber. First cut ten to twelve years ago by Cyrus Cole. Now being lumbered by Hazeltine Brothers and the Adams mill.
YIELD.................About 500 to 1,000 feet per acre. Of cord wood, 8 to 10 cords per acre.
TRANSPORTATION.....Road through entire district.

BATTLE CREEK.

This district comprises the region drained by the main or north fork of Battle Creek, and includes within the timber limits an area of 68.7 square miles. The southern branches of the creek drain the eastern slopes of the Harney Peak Range, and head among the rugged, precipitous mountains of that region. They flow through deep canyons among the rough, serrated granite walls and cliffs, which tower 500 to 800 feet on each side, forming the most rugged, impenetrable part of the hills. These narrow canyons are often choked with a jungle of spruce, aspen, birch, and willow, which in many places have been burned and later blown down, making exploration slow and arduous.

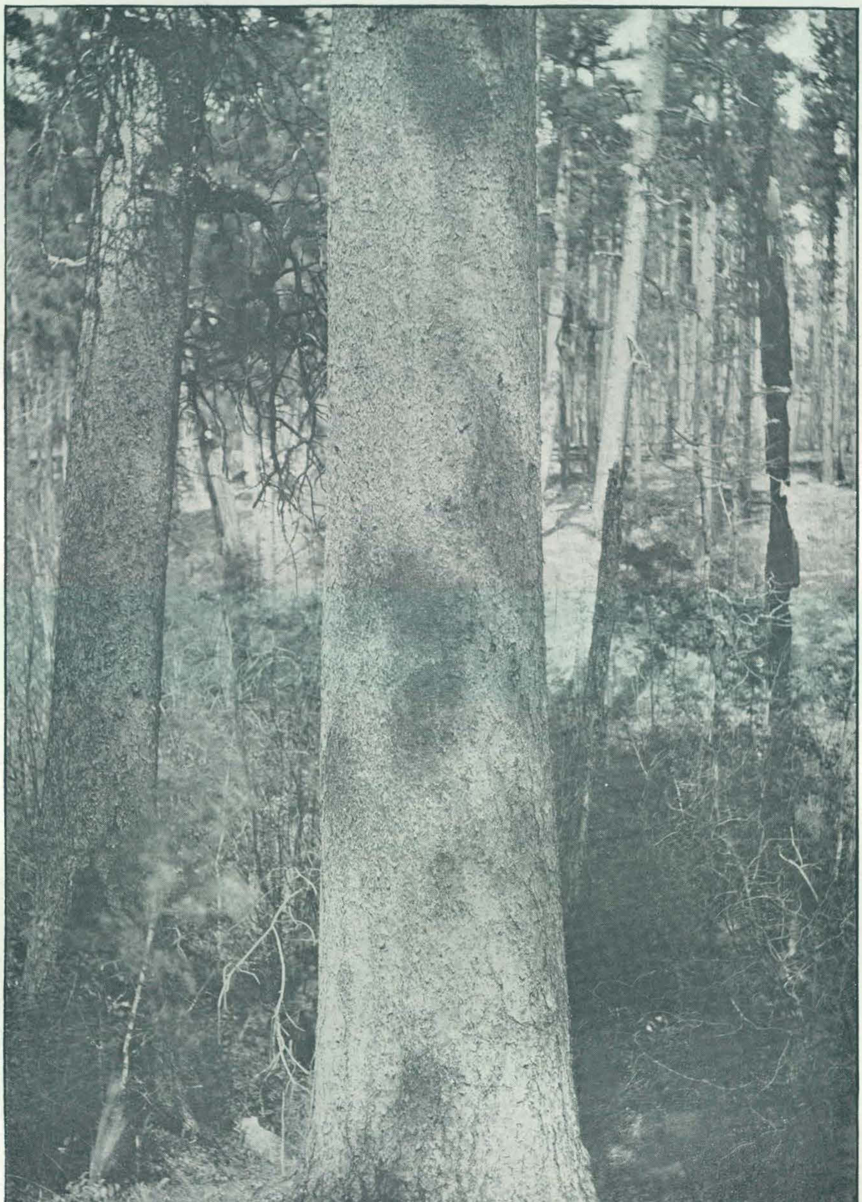
The northern branches, Tepee and Foster creeks, head in a more level country, where the schist predominates. The region is well watered, and in the bottom lands the soil is a rich sandy loam. On the high plateaus and ravines the soil is a coarse gravel.

There is in this region a large amount of old timber of excellent quality. In the rugged country at the heads of the streams the large timber is confined to the bottoms of the canyons. Here trees as large as 36 inches in diameter are found with beautiful long, clear stems, and apparently perfectly sound. On the high slopes of Harney Peak there is a dense growth of young poles, probably about 60 years old. The old forest at the headwaters of the streams is in many places broken by fire. The illustration, Pl. XXX, shows the character of the forest in the ravines. There is a large amount of lighter and younger timber, estimated to be about 150 years old, on the road from Custer to Keystone, farther east. The trees are 14 to 18 inches in diameter, and are estimated to have a yield of 3,000 feet of saw lumber per acre, besides a large amount of timber suitable for props. On the high flats toward Keystone the timber is older and would yield probably 1,000 feet more of saw lumber per acre.

One of the heaviest bodies of timber lies between Keystone and Hill City. The trees average about 22 inches in diameter, and are estimated to be 80 to 90 feet high, with a clear length of 30 to 40 feet. This timber would in places yield 10,000 to 15,000 feet per acre. Large trees are found on the slopes, and at a relative altitude of 400 feet yield in places 4,000 feet per acre. For the most part the trees are much lighter on the higher slopes, and on the ridges toward Harney Peak are stunted and scrubby.

On Tepee and Foster creeks and on the road from Rockerville to Hill City there are bodies of timber having a yield of about 4,000 feet per acre. At the very head and on the lower part of Tepee Creek the saw lumber has been removed. There has also been a large amount cut in the immediate vicinity of Keystone. East of Harney the forest is composed chiefly of scrubby, defective trees, with some second growth, which is too small for lumber. The forest is open and broken by small prairies and parks. The average density in this whole region is about 0.6, including the various openings within the forest. The reproduction is for the most part very good, but in the bottoms of the canyons and on the grassy hills and parks at the edge of the timber it is exceedingly slow.

Besides the pine, which covers the greater part of the area, spruce is found at high elevations and in deep, cool, moist canyons, but is nowhere of merchantable size. Aspen and birch are very abundant on burnt areas, especially at the heads of the streams. In the lower sections the ravines are filled with oak, elm, ironwood, and willow, with some aspen and birch, and such shrubs as hazel, dogwood, nine-bark, elder, choke-cherry, etc. Oak attains a diameter of nearly 1½ feet in this section and is sometimes tall enough for one saw log. Most of the oaks are sprouts, probably from old fires. Elm was also found over a foot in diameter.



A VETERAN PINE TREE, 3 FEET IN DIAMETER, ON SQUAW CREEK, SOUTH DAKOTA.

The following sample plots serve to present more clearly the condition of the forest:

Sample plots studied in Battle Creek region.

No.	Merchantable trees.		Other trees.		Board feet.	Cord wood.	Tops.	Dead trees.		Area.	Place.	Density.
	Number.	Average diameter.	Number.	Average diameter.				Number.	Cords.			
		In.		*In.*		*Cords.*	*Cords.*			*Acres.*		
10	9	16	16	15	1,300	5.0	2.0	5	2.0	½	Iron Creek....	0.5
11	11	17	46	11	2,200	7.0	3.0	2	0.8	½	.....do	0.7
63	5	15	50	11	500	8.0	0.8	2	0.6	½	Keystone......	0.6
64	13	20	8	17	3,200	4.0	5.0	3	1.5	½	.....do	0.6
65	8	20	12	15	2,000	4.0	3.0	....	.....	½	Glendale	0.6
66	9	16	5	17	1,300	2.5	2.0	4	0.5	½	.....do	0.6
67	2	19	12	15	450	4.0	0.8	1	.....	½	Harney	0.3
68	5	19	15	11	1,200	2.5	2.0	....	.....	½	.....do	0.5
69	12	20	11	21	3,000	8.0	4.5	....	.....	½	Keystone......	0.5
70	8	21	16	14	2,500	4.5	4.0	....	.....	1	.....do	0.3
71	16	19	7	18	4,000	4.0	6.0	1	0.4	½	Tepee..........	0.5
72	8	20	23	13	2,000	3.0	3.0	1	.....	½	Rockerville to Hill City....	0.6

It is estimated that there are 17,088 acres covered with pine yielding 4,000 feet per acre, 1,600 acres with 7,000 feet per acre, 4,800 acres with 2,500 to 3,000 feet per acre, and 7,936 acres with only scattered timber which yield a total of 4,000,000 feet. The estimated stand for the whole region is 98,000,000 feet of lumber and 700,000 cords of wood, not including tops. Of the total amount of timber standing in this region it is estimated that 90 per cent is accessible.

While the entire forest shows the effect of fires, especially on the ridges, the greatest damage has been done on Iron Creek. This region is said to have been burned ten years ago. In 1893 a most disastrous fire swept over the same district, destroying a large amount of timber and nearly all the growth which had come up after the preceding fire. The rough section on the eastern slopes of Harney Peak has been burned at different times, but the timber in the deep canyons has for the most part escaped serious injury.

There are approximately 12.4 square miles in this region which have been cut over for lumber. The first cutting was in about 1889, by Cyrus Cole. The lower part of Tepee Creek is said to have been cut in 1891 by Beardshear, and the district at the head of the creek was cut for the mill now owned and operated by J. C. Carter, of Rockerville. There is one other mill in operation, owned by Theo. Reder, which is situated about 2 miles west of Keystone. The timber to supply the mines at Keystone has been for the most part taken from the district directly south of the town.

Mining is the chief industry of the region, and near Keystone is found one of the most important mineral belts in the central hills. Here the Holy Terror and Keystone mines employ a large number of men, both in connection with the mines and in the forest, manufacturing lumber and props and cutting cord wood. At Wealthy there is a stamp mill in operation, and at Glendale, Bismuth, and Keystone there are mills which at present are idle. Much of the country between Bismuth and Rockerville is said to be taken up in mineral claims, doubtless some of which were located for the purpose of defrauding the Government of the timber. Throughout the section near Keystone miners are busily engaged in prospecting and developing mines already discovered. The Etta tin mine is situated near Keystone, but at present no work is being done.

There are many places where enough land is found to make ranching profitable. These places are usually at the junction of two streams, where the valley opens out into broad parks. There are between 45 and 50 ranches in the whole region.

District No. 23.—Iron Creek.

Rock ....Mostly granite and schist.
Soil ....Fresh porous sandy loam or gravel; slopes stony.
Litter ....Medium.
Humus ....Half inch; on ridges badly burned.
Forest ....In ravines a heavy growth of old timber, which reaches a diameter of 30 inches and a height of 90 feet, and has an average clear length of 25 to 30 feet. On broad flat ridges chiefly a fairly dense forest of large poles, about 160 years old and 14 to 16 inches in diameter, mixed with young trees too small for lumber. Within canyon small spruce, birch, and willow are found
Density ....0.6.
Reproduction.......Good.
Dead timber ....About 6 per cent.
Cutting ....A small amount cut near Bismuth by Cyrus Cole, six to eight years ago.
Fire..................Evidences of old fires through the entire district. Large tract south of creek burned ten years ago and again four years ago.
Yield................In many canyons 8,000 to 10,000 per acre; over whole uncut area 3,000 to 5,000 feet per acre. Other material would average 12 to 15 cords per acre.
Transportation ....All timber in the lower part of the district easily accessible. In the western portion there are no roads and the timber is difficult of access.

District No. 24.—Grizzly Gulch.

Rock ....Mostly granite and schist.
Soil ....Gravel, and in some ravines sandy and clayey loam.
Litter ....Thick.
Humus ....One-third inch except on steep slopes and stony ridges.

FOREST..............In western portion mostly a second growth about 60 to 80 years old with a fair density. In the eastern portion the canyon bottoms are covered with old timber averaging 20 to 22 inches in diameter and 70 to 80 feet high. On the slopes the timber averages 16 to 18 inches. Small spruce, aspen, white birch, and willow are abundant in canyons. At low elevations oak 1 to 2 feet through, elm 1 to 1½ feet, ironwood, choke and pin cherry, hazel, nine-bark, snowberry, service berry, and Shepherdia occur in ravines.

DENSITY..............0.5 to 0.6.

REPRODUCTION.......Good.

DEAD TIMBER........5 to 10 per cent.

CUTTING..............Lumber has been cut near the Etta mine and near Theo. Reder's sawmill; mine props and cord wood on the Custer road.

FIRE..................Old timber is badly scarred by ancient fires, but has remained pretty sound. Several large burnt tracts about halfway between Etta and Harney Peak.

YIELD................In a small section between Keystone and Hill City, 10,000 to 15,000 feet per acre. Most old timber yields about 4,000 feet, and cut-over land 300 to 500 feet per acre. Of other material the yield is 10 to 15 cords per acre.

TRANSPORTATION.....There are roads in the eastern portion, but in the western section the timber is difficult of access.

DISTRICT No. 25.—GLENDALE.

ROCK.................Granite and schist with some quartz.

SOIL..................On ravine bottoms partly a rich clayey loam and partly gravel; on steep slopes thin and stony.

LITTER...............On bottom lands thick; on slopes and ridges scanty.

HUMUS................One-half inch.

FOREST..............West of Glendale, veteran forest of pine about 20 inches in diameter and 75 feet high, broken by patches of poles about 100 years old and 10 to 14 inches in diameter. The old timber has an average clear length of 20 to 30 feet and is fairly sound. East of Glendale an open forest of defective trees about 16 inches in diameter and of second-growth poles broken by numerous parks. In ravines are found small oak, ironwood, birch, aspen, willow, hazel, dogwood, nine-bark, etc.

DENSITY..............0.6.

REPRODUCTION.......Excellent, except on canyon bottoms and near parks.

DEAD TIMBER........5 per cent.

CUTTING..............Severe cutting near Keystone for lumber, props, and cord wood. Near the edge of timber line forest has been culled for cord wood by ranchers.

YIELD................In the old forest, about 4,000 feet per acre. On the whole area, about 10 to 12 cords per acre of small or defective trees.

TRANSPORTATION....Roads in all parts of the district. Practically all timber accessible.

DISTRICT No. 26.—PINE CREEK.

ROCK.................Chiefly granite, schist, and quartz.

SOIL..................In ravines, a fresh, fairly deep, sandy or clayey loam or a gravel; on slopes, thin and stony.

LITTER................Fairly good.
HUMUS ....One-third inch.
FOREST ....In eastern forest, a veteran forest averaging 20 to 24 inches in diameter and 80 to 90 feet high, with many trees 30 to 32 inches in diameter. There are numerous patches of timber about 100 years old and 10 to 14 inches in diameter. Near Harney Peak, chiefly a second growth about 60 years old. In the eastern section the forest has been cut over and is now composed of small or defective trees. In canyons and at high elevations small spruce is abundant, and aspen, white birch, oak, elm, and willow are found.
DENSITY ....0.5.
REPRODUCTION.......Good.
DEAD TIMBER ....5 to 10 per cent.
CUTTING ....The larger part of the merchantable timber has been removed in the western section by the Harney Peak Mining Company.
YIELD.................The heaviest timber yields 10,000 to 15,000 feet per acre; the greater portion of the district about 4,000 feet per acre. The scrubby and small trees will yield about 8 to 10 cords per acre.
TRANSPORTATION.....A large part of the best timber is difficult to take out.

DISTRICT NO. 27.—BUCKEYE CREEK.

ROCK ....Chiefly schistose.
SOIL ....On moderate slopes and bottom lands a fresh, strong, fairly deep clayey loam.
LITTER...............Thick.
HUMUS................One-third inch.
FOREST ....A virgin forest of pine, averaging 20 inches in diameter and 75 to 80 feet high, with an average clear length of about 25 feet, mixed with patches and individual specimens of second growth about 12 to 14 inches in diameter. On rich depressions aspen, birch, willow, etc., are abundant. On ridges and slopes, trees about 16 inches in diameter and 60 to 70 feet high.
DENSITY ....0.6.
REPRODUCTION.......Medium.
DEAD TIMBER ....About 4 per cent.
CUTTING ....At extreme western portion culled for lumber by the Harney Peak Mining Company.
FIRE ....Forest broken and trees injured by ancient fires. Recent fires have done less injury.
YIELD.................In virgin forest, about 4,000 feet per acre. Over whole area, about 10 to 12 cords per acre of timber unfit for lumber.
TRANSPORTATION.....Practically all timber accessible to the Hill City-Keystone road or Hill City-Rockerville road.

DISTRICT NO. 28.—KEYSTONE.

ROCK ....Chiefly granite, schist, and quartz.
SOIL ....On bottom lands clayey loam and gravel; on slopes and ridges mostly gravel.
LITTER ....Heavy in ravines; thin on ridges and steep slopes.
HUMUS ....Two-thirds inch.

FOREST ....Old stand of pine, averaging 18 to 20 inches in diameter and 70 to 80 feet high, with numerous groups of second growth about 10 to 14 inches in diameter. On bottom lands oaks are found as large as 18 inches in diameter and 40 feet high and elm 12 to 18 inches in diameter. Ironwood, box elder, aspen, birch, and shrubs are abundant.

DENSITY ....0.5.

REPRODUCTION ......Good.

CUTTING ....Near Keystone the forest has been heavily thinned to supply the town with mine timbers and fuel.

FIRE..................A large percentage of the trees show effect of old fires. Many trees unsound.

DEAD TIMBER........5 per cent.

YIELD.................On uncut tracts, 4,000 feet per acre. On lumbered land, 300 to 500 feet per acre. Of defective, scrubby, and small trees, 10 to 12 cords per acre.

TRANSPORTATION.....Several roads cross the district, meeting at Keystone.

DISTRICT NO. 29.—TEPEE CREEK.

ROCK ....Chiefly schist.

SOIL ....On lower slopes and bottoms rich, fairly deep, fresh clayey loam.

LITTER ....Thick.

HUMUS ....Two-thirds inch.

FOREST ....An original forest of pine, reaching a diameter of 30 inches and a height of 90 feet, with stems clear for 25 to 30 feet, mixed with poles about 10 to 14 inches in diameter. On bottom lands, oaks 8 to 10 inches in diameter and 35 to 40 feet high are abundant.

DENSITY ....0.5.

REPRODUCTION.......Medium.

DEAD TIMBER.........About 4 per cent.

CUTTING ....Lower portion of Tepee Creek culled of largest lumber to supply local market. Upper portion cut over for sawmill, now owned by J. C. Carter.

FIRE ....A large number of trees show injury by ancient fires, and many trees are unsound through this cause.

YIELD.................In unlumbered tracts, 4,000 feet per acre. On cut-over land, 300 to 500 feet per acre.

TRANSPORTATION.....All timber accessible to wood roads which run through the district.

DISTRICT NO. 30.—FOSTER CREEK.

ROCK and SOIL.......As in district No. 29.

FOREST ....At the head of the creek there is a body of old timber similar to that on Tepee Creek. The lower portion is covered with an open forest of pine, which is for the most part composed of scrubby, defective, or young trees and is interrupted by open parks. Species in mixture same as on Tepee Creek.

DENSITY ....0.5.

REPRODUCTION.......Poor.

CUTTING ....Culled for timber for local use on the Rockerville road and in the lower portion.

YIELD.................In the untouched portion, 4,000 feet per acre. Elsewhere, 300 to 500 feet per acre. Other material, on an average 8 to 10 cords per acre.

SPRING CREEK.

Spring Creek forms one of the largest and most important regions of the eastern hills. It has a continuous stream of water from its headwaters to the point where it finally sinks in the limestone formation below the timber line. There are two important forks, which come together near the present site of Hill City, meeting at a wide angle. The northern branches of the South Fork head within the open parks of the limestone region and flow through narrow canyons into the more open country of the schist formation. The southern branches rise among the granite and schist mountains on the western side of the Harney Peak Range.

The streams flow through broad open parks with rich, productive soil, and below the point where the two forks come together the main creek enters a formation of hard slate, through which it has cut a narrow canyon. Where the side streams enter the creek, as at Sheridan, there is a considerable amount of rich agricultural land; elsewhere the canyon is narrow, with rugged slopes and cliffs on each side. The total timber area drained by the Spring Creek system is 166.4 square miles. The entire region was formerly densely, and in most parts heavily, wooded, and there are still left some extensive bodies of the finest timber in the Dakota portion of the Black Hills.

On the northern branches of the South Fork there is a magnificent body of old timber, averaging 22 inches in diameter and 75 to 90 feet high, with a yield of 5,000 feet per acre. This forest is in many places broken by fire, and considerable areas of timber have been destroyed. In the limestone portion the timber has been badly burned, and is now for the most part an irregular second growth. The old timber begins at the edge of the limestone.

At the head of the North or Newton Fork the forest is very irregular on account of fires. There is considerable original forest along the ravine bottoms, yielding about 3,000 feet to the acre, while the slopes and ridges are covered with an irregular growth of young timber.

The forest along the railroad on each fork has been severely culled by lumbermen. The merchantable lumber has been removed for about 2 miles on each side of the road, and in the northern portion of the region the entire area has been stripped for mine timbers and cord wood. In the narrow canyons around Harney Peak there is still a good deal of old timber, but it is practically inaccessible. The high ridges and slopes around Harney Peak are covered for the most part with a second-growth forest of pine, and at very high elevations spruce is found both in the canyons and on the slopes and exposed ridges.

Between Sheridan and Rockerville the forest was culled of the best timber in 1880, when the flume between these points was built, but there is still a fair amount left in the less accessible localities. On Horse Creek there is a body of very fine old timber, but it is being removed by the Fish & Hunter Lumber Company. Here the trees are exceptionally tall and clear boled and fairly sound. The soil in the lower slopes is very productive, and trees only 120 to 130 years old can be used for saw lumber.

The forest north of Sheridan is broken by a large prairie, called the Bald Hills, which extends to the head of Victoria Gulch and to within a few miles of Pactola. The forest on the lower portion of Spring Creek has been seriously injured by fires, especially on the ridges, and the old timber is confined to canyons and protected ravines. On the ridges the timber is chiefly of two age classes, about 160 and about 100 years old, and there are some patches of poles about 50 to 60 years old. The average diameter of the ridge timber is about 14 inches and the height 60 feet. The timber in this section averages about 3,000 feet per acre, except along the roads, where it is not over 1,000 feet per acre.

On cut-over lands there is in some places as much as 500 feet of saw lumber per acre left by the lumbermen. Near Redfern, where cord wood has been cut, there is nothing left but small second-growth saplings. The cut-over lands are estimated to average about 300 feet per acre of saw lumber. The total stand in the region is estimated at 65,000,000 feet of saw lumber and about 1,200,000 cords of other material.

There is some spruce timber on Spring Creek, in the narrow canyons, and while a few trees are found near Rockerville, it is for the most part confined to the head of the various branches. Aspen is abundant on burnt areas, and white birch is found in considerable quantities at higher elevations. At lower elevations oak, ironwood, box elder, elm ash, and various shrubs occur on the ravine bottoms.

The following measurements were taken in this region:

Sample plots studied in Spring Creek region.

No.	Area.	Merchantable trees.		Stumps after lumbering.		Other trees.		Board feet.
		Number.	Average diameter.	Number.	Average diameter.	Number.	Average diameter.	
	Acres.		*Inches.*		*Inches.*		*Inches.*	
12	½	3	15	6	20	21	16	*a* 1,500
13	½	2	15	14	20	22	10	*a* 2,000
14	½	7	14	9	18	25	12	*a* 2,000
15	½	6	15	8	16	30	10	*a* 1,000
16	½	13	15	0	0	21	11	1,300
48	½	13	17	......	....	9	15	2,600
49	½	6	22	......	....	16	11	2,000
50	½	16	22	......	....	12	14	5,300
59	½	26	20	......	....	7	15	7,000

a Taken.

Sample plots studied in Spring Creek region—Continued.

No.	Cord wood.	Tops.	Dead trees.			Density.	Place.	Board feet.
			Number.	Average diameter.	Cords.			
	Cords.	*Cords.*		*Inches.*				
12	8.4	2.0	2	11	0.3	5.0	Grizzly Bear...	*a* 300
13	5.0	5.0	0	0	0.0	5.0	.....do	*a* 200
14	5.0	3.0	0	0	0.0	5.0	Spring	*a* 700
15	3.5	1.5	2	14	0.3	5.0	.....do	*a* 600
16	3.5	2.0	2	9	0.2	5.0	.....do	....
48	3.0	4.0	0	0	0.0	4.0	Near Oreville..	....
49	2.5	3 0	0	0	0.0	4.0	Head Spring ..	....
50	3.5	8.0	......	......	......	7.0	.....do	....
59	2.4	11.0	2	14	0.5	1.7	.....do	....

a Left.

There are approximately 80 square miles in this region culled of the best merchantable timber. About Hill City the timber was cut by the Harney Peak Mining Company. On Newton Fork Laudon's mill was operated in 1891, and E. H. Farnsworth, who is now cutting on Marshall Gulch, was cutting in the same region in 1895 and 1896. The country in Patterson Gulch was cut by Sterns Brothers, who have moved their mill about 2 miles north of Hill City. A large amount of mine timbers and cord wood has been cut near Redfern for the Homestake Company. The mills owned by J. E. Blaine and Thomas W. Harris are operating a few miles south of Hill City, and the waste of timber on this tract is unequaled by anything seen in the hills. At Oreville, M. A. Tipton owns a sawmill and is cutting logs on the slopes west of this point. A sawmill has lately been moved to the head of one of the south branches on the old Deadwood road and is cutting in the large timber described in the first part of this section.

The most fire-scarred sections in the entire region are at the head of the North Fork and near the Bald Hills. Everywhere throughout the district old fires have left their traces on the timber.

A fire in 1894 killed a large amount of timber at the head of the north branch of the Middle Fork, and about the same time a severe fire burned over the lumbered tract on the south side of Newton Fork. A fire during the summer of 1897 burned for several weeks north of Hill City.

Besides lumbering, mining and ranching form the chief industries. At Hill City there is a mill at the tin mine, where at one time a large number of men were employed, but which is not being operated at present. The most important mines that are being worked to-day

A. A PINE FOREST AFTER LUMBERING, NEAR HILL CITY, SOUTH DAKOTA.

B. WASTEFUL METHODS OF LUMBERING NEAR HILL CITY, SOUTH DAKOTA.

are the Sunnyside, near Hill City, with a 5-stamp mill; the Grizzly Bear, with a 2-stamp mill; St. Elmo, with a 2-stamp mill, and the G. A. R., with a 10-stamp mill. There are a large number of smaller mines which are being developed and on which annual assessment work is done.

There are within the region over 60 ranches, most of which are scattered along open parks near the railroad. At the head of the Middle Fork there is considerable land covered with forest which would be suitable for agriculture. Elsewhere the best agricultural land has been taken up.

District No. 31.—Rockerville.

Rock ....Chiefly hard slate; at eastern edge limestone.
Soil..................On slopes, thin and stony; on flats, fresh clayey loam
Humus ....1 to 2 inches.
Litter...............Thick on bottom lands.
Forest ....Western portion, irregular forest of fire-scarred old timber mixed with high poles about 160 years old, which are just coming to merchantable size, and a large amount of poles about 100 years old which average 12 inches in diameter. Eastern section, old timber, mostly confined to inaccessible canyons and ravines. Slopes covered chiefly with a pole forest 12 to 16 inches in diameter and mostly from 100 to 160 years old. In canyons are found oak, ironwood, aspen, ash, elm, hazel, chokecherry, etc.
Density ....0.6.
Reproduction.......Good.
Cutting.............Practically all easily accessible saw lumber removed in eastern portion. Cut over for flume in 1880 by Gates. Kingman & Murphy also operated near Rockerville. Near Wealthy, timber cut for mill now owned by J. C. Carter.
Fire.................Of veteran timber in canyons 75 per cent injured by fire at butt. Many unsound trees in consequence. In western portion 2,000 board feet per acre. Other material 10 to 12 cords per acre.

District No. 32.—Sheridan.

Rock ....Chiefly slate.
Soil ....Fresh clayey loam
Humus and litter...Thin.
Forest ....Broken stand of pine 15 to 18 inches in diameter and 60 to 70 feet high, with patches of larger trees, and numerous groups of poles about 100 years and 50 years old, and saplings 20 to 30 years old. On burns and on bottom lands much aspen and birch. Oak occurs in small quantities.
Density ....About 0.4.
Reproduction.......Good.
Cutting ....Nearly all saw lumber removed from the lower portion of the district.
Yield................Uncut portion about 2,000 feet per acre of saw lumber. Of other material about 10 to 15 cords per acre.

FIRE .... Old fires did serious damage to old lumber, nearly 50 per cent showing injury at butt. Recent fires killed considerable small second growth.

TRANSPORTATION ..... Roads in lower portion of district. Uncut timber not difficult of access.

DISTRICT No. 33.—PALMER GULCH.

ROCK .... At southern end, granite and schist; near Spring Creek, hard slate.

HUMUS and LITTER .. For the most part thin.

FOREST .... On slopes of Harney Peak, mostly a second growth about 60 to 80 years old, of good density. Large part of district heavily thinned by fire and cutting. Except in inaccessible canyons at the foot of Harney Peak and on some mineral claims there is practically no saw lumber left. What remains is chiefly scrubby old timber mixed with second-growth poles. In canyons aspen, spruce, birch, and willow abundant.

DENSITY .... Poor.

REPRODUCTION .... Good at high elevations; elsewhere medium.

CUTTING .... Nearly all saw lumber cut at northern portion. Chiefly cut by Harney Peak sawmill.

YIELD .... 5 to 10 cords per acre.

DISTRICT No. 34.—GRIZZLY BEAR.

ROCK .... Chiefly granite and schist.

SOIL .... In part gravel; in part clayey loam.

LITTER and HUMUS .. Mostly thin.

FOREST .... Around Sylvan Lake, timber mostly light, 12 to 18 inches in diameter, but tall and clear; above the lake, chiefly a second growth of low poles. West of Harney Peak, in ravines, old timber up to 3 feet in diameter is found, mixed with second-growth pine, about 60 years old, and spruce. West of road, on slopes, much second growth about 20 to 30 years old. Lower part of district mostly cut over except on some mineral claims. What remains is chiefly scrubby old timber, poles about 160 and 50 years old, and saplings about 30 years old. Average diameter about 12 to 14 inches. In canyons, aspen, spruce, birch, and willow.

DENSITY .... 0.4 to 0.5.

REPRODUCTION .... Good.

DEAD TIMBER .... 5 per cent.

CUTTING .... 75 to 80 per cent saw lumber removed on lower part. Cutting chiefly in last six years by M. A. Tipton, J. E. Blaine, and Thos. W. Harris.

TRANSPORTATION ..... Road through entire district. Large part of timber at foot of Harney Peak is inaccessible.

DISTRICT No. 35.—HEAD SOUTH FORK.

ROCK .... Chiefly schist.

SOIL .... Fresh, rather deep, clayey loam.

HUMUS .... 1 to 3 inches.

LITTER .... Good.

FOREST ....Heavy timber, averaging 22 inches, with many trees over 2½ feet in diameter, very tall and with clear boles of 30 to 50 feet. Fairly sound. Many patches of poles about 100, and also about 50 to 60, years old. Eastern section culled of a large part of saw lumber. Small spruce abundant in canyons.

DENSITY ....0.6 to 0.7.

REPRODUCTION.......Good.

CUTTING ....About 75 per cent of saw lumber removed in eastern portion of district. One sawmill at Oreville and one on old Deadwood road.

YIELD.................In old forest at head of creek, 6,000 to 8,000 feet per acre. Elsewhere in untouched timber, 3,000 to 5,000 feet per acre; of cord wood, 10 to 15 cords per acre. Nearly all timber accessible.

DISTRICT NO. 36.—FRANKLIN GULCH.

ROCK ....Granite, schist, and quartz.

SOIL ....Gravelly on slopes; on bottoms, fresh loam.

HUMUS ....1 to 2 inches.

FOREST ....Eastern portion culled of saw lumber. What remains is composed of small, defective, or scrubby pines, 15 to 18 inches on an average and yielding under 500 feet per acre. Considerable amount of timber about 150 years old, and patches of saplings not over 40 years old. In western portion, strips of old timber along creek bottoms, but slopes covered with light timber or scattered sapling growth.. Aspen and willow abundant.

DENSITY ....0.4 to 0.5.

REPRODUCTION.......On high elevations and on north slopes, very good; near parks, poor.

DEAD TIMBER ....About 3 per cent.

YIELD.................On bottoms of ravines, 3,000 to 4,000 feet per acre.

CORD WOOD..........10 to 12 cords per acre.

CUTTING ....Eastern portion culled of fully 75 per cent of saw lumber. In large part cut by M. A. Tipton.

TRANSPORTATION ....Most of timber accessible.

DISTRICT NO. 37.—HEAD MIDDLE FORK.

ROCK ....Chiefly schist; in western portion, limestone.

SOIL ....Fresh loam on bottom lands.

HUMUS ....1 to 2 inches.

FOREST ....In limestone section, chiefly second growth of various ages, 100, 60 to 80, and 20 to 40 years old, with a few scattered veterans. Old timber begins with schist formation; 18 to 24 inches in diameter, 70 to 90 feet high, often with clear length of 2 to 3 logs; mixed with patches of 100-year-old poles. Some slopes covered, for the most part, with second growth. Aspen and small spruce abundant in ravines. Aspen as large as 12 and 14 inches.

DENSITY ....0.6.

REPRODUCTION.......Very good.

FIRE....................Great damage by old fires. Large tract burned three years ago and everything killed.

YIELD.................At head of creek, 5,000 to 6,000 feet per acre; in eastern section, about 3,000 feet per acre.

TRANSPORTATION.....Timber nearly all accessible to old Deadwood road.

DISTRICT NO. 38.—HEAD NEWTON FORK.

ROCK ....Schist.
SOIL..................Clayey loam. On bottom lands fresh and fairly deep.
HUMUS and LITTER ...Scant.
FOREST ....At head, old timber chiefly in ravines; 18 to 22 inches in diameter, tall and clear boled, with many patches of poles about 100 years old. Slopes and ridges badly burned, in some cases bald, others covered with a scattering growth of saplings 20 to 40 years of age. Eastern portion of district culled of nearly all saw lumber.
DENSITY ....0.4.
REPRODUCTION.......For the most part excellent.
CUTTING..............Cutting has been going on for about fifteen years.
FIRE..................Western portion very severely damaged by old fires, especially the ridges, which in many cases are now bare. Eastern portion burned two to three years ago on lumbered tract.
TRANSPORTATION.....Timber for the most part accessible.

DISTRICT NO. 39.—MARSHALL GULCH.

ROCK ....Chiefly schist.
SOIL ....Fresh clayey loam; slopes stony.
HUMUS and LITTER ..Thin.
FOREST ....All cut over. On western part, stripped for mine timbers and cord wood; the rest culled for saw lumber. What is left is 16 to 18 inches through on an average, and for the most part scrubby or defective, with many patches of thrifty poles not yet large enough for lumber. Aspen abundant.
DENSITY ....0.5.
REPRODUCTION.......Good.
CUTTING ....First cut in eastern section for Rockerville flume in 1880. Western part cut by different parties, mostly in last six years. Two mills now operating in district.
YIELD..................Of lumber, 200 to 300 feet per acre. Of cord wood, 8 to 10 cords per acre.
TRANSPORTATION ....Timber accessible.

DISTRICT NO. 40.—HORSE CREEK.

ROCK ....Slate.
SOIL...................Fresh, rather stony, loamy clay.
LITTER and HUMUS ..Good.
DENSITY..............0.5.
REPRODUCTION ......Excellent.
FOREST ....Mixed forest of old veterans, middle-aged standards, and second-growth poles. Character of timber, unusually long and clear. Trees up to 2½ feet in diameter, with a maximum height of 80 to 90 feet, yielding 2 to 3 logs per tree.
FIRE..................Recent fires have done almost no damage. A good many old trees are seriously injured at the butt by old fires, in oldest timber fully 50 per cent.
CUTTING ....Only the finest timber taken. At the lower end of the creek saw timber was removed several years ago. The Fish & Hunter mill is now sawing the rest of the saw lumber. On the upper end fully half the ground is covered with small timber. A large amount of mining timbers left.

BIG RAPID CREEK.

Big Rapid Creek is formed by the union of Little Rapid and Castle creeks, and is equaled in volume of water by no stream in the hills except Spearfish Creek. The region drained by this stream is broken into high peaks and narrow ridges in the slate portions, and where the creeks enter the limestone a deep canyon has been cut. The bordering limestone plateaus are likewise broken by ravines. At the points where tributary streams meet Big Rapid the valley widens out and there are usually flats extensive enough for farming purposes. In the valley the soil is deep and productive, on the slopes stony and thin.

The forest in this region has been much broken by fire, which has not only stripped entire mountains of all tree growth, but has left the forest elsewhere in a broken, irregular condition and the trees badly injured at the butt. In the rugged portion of the region above Pactola there has been comparatively little lumbering, and there is a large amount of timber on the slopes and in the ravines and canyons back from the valley. This timber is about 18 inches in diameter on an average and about 70 feet high. On the slopes and ridges it is unsound, probably fully 50 per cent of the trees showing decay. On the upper part of Jenny Gulch and on Deer Creek the saw lumber has been removed. There is still considerable timber at the head of Nugget Gulch and on Bear Gulch, where the forest is interrupted by patches of burnt land, which in some cases are becoming restocked with a fine growth of young timber. The good reproduction at the head of Bear Gulch is especially to be noted. Near Mystic thickets of spruce, box elder, elm, willow, and aspen follow the creek. Below, near Silver, the valley is somewhat broader and there are wide flats covered with grass and weeds. In this section the reproduction of pine is very poor, chiefly on account of the condition of the soil. In Pennington and Victoria gulches the timber is still untouched, and here occur some very large specimens of yellow pine. On the higher slopes were seen patches of timber about 100 years old, and in some of the side ravines timber of merchantable size about 150 years old. Near the Bald Hills are patches of timber of nearly age class.

Besides the species already mentioned as growing along Rapid Creek were noticed white birch, hazel, dogwood, chokecherry and pin cherry, service berry, elder, and raspberry, and on the lower part of the creek and on Victoria Gulch oak, ironwood, and green ash. Note was also made of a few red cedar on high limestone divides, as well as aromatic sumac, poison ivy, and Ceanothus.

The forest after cutting usually contains about 40 trees per acre, averaging about 14 inches in diameter. The whole forest, not including burnt tracts, was estimated to have a density of 0.5.

There are about 27 square miles still stocked with old forest, with an average yield of 2,500 feet per acre, and about 8.5 square miles with

5,000 feet per acre. It is estimated that on the remainder there are altogether 10,000,000 board feet, and 900,000 cords would probably cover the fire wood. The greater part of the 80,000,000 board feet in this section is difficult of access.

Approximately 19 square miles have been lumbered in this region. The first mills were brought into the country in 1877, when the Rapid Creek Mining Company cut some timber above Pactola. The next year another mill was moved into the same district, and in 1878 removed to Deer Creek. Since then there has been a mill on Kelley Gulch, owned by McGee, who sawed timber for the railroad which was to run up the creek, and at the Big Bend Scott had a mill for the same purpose. Pinkerton owned a mill near the mouth of the canyon, and to-day there is a mill in operation on Jenny Gulch. T. J. Elliott cut for a good many years on Deer Creek, and moved in 1896 to Box Elder.

This region has suffered severely from fire at different periods. The Bald Hills were brought into their present condition by fire, and everywhere traces of old fires are found on the trees. Probably the high bare hills near Silver were cleared by the fire which occurred fifty-five years ago. In 1878 there was a severe fire between Silver and Pactola; in 1892 one between Pactola and Spring Creek, and in 1893 one in the Deer Creek country.

Mining is the chief industry of the region. Below Mystic there are a large number of miners engaged in developing prospects, and a small amount of placer mining is still carried on. Two stamp mills are in operation—the Broken Bow and the Unknown—and throughout the region there are mines of value which have not been fully developed. Between 20 and 25 ranches lie within the region. The greater amount of tilled land is put into oats, although vegetables are raised to some extent. There are estimated to be about 350 horses and cattle in the vicinity of the Bald Hills.

DISTRICT 41.—PENNINGTON GULCH.

ROCK ....Slate and limestone.

SOIL ....In ravines a rich clayey loam; elsewhere stony and meager.

HUMUS and LITTER ...Thin, except in ravines.

FOREST ....Large part of easily accessible timber has been removed along Rapid Creek and on the divides near the edge of timber line; on limestone formation, chiefly an open forest of defective old trees mixed with second-growth poles, or a scattering young growth under 50 years old. On cut-over land in slate section forest is a broken stand of defective and scrubby trees, 12 to 18 inches in diameter, mixed with second growth of various ages. On Victoria Gulch and a part of Pennington Gulch there is a body of old timber which reaches a diameter of 2½ feet and a height of 90 feet, with long clear stems. In canyons oak, ash, aspen, birch, box elder, elm, cherry, service berry, ironwood, nine-bark, haw, dogwood, and other shrubs occur. Bald Hills Prairie is devoid of tree vegetation, except a few patches of fair-sized timber.

DENSITY..............0.5.
REPRODUCTION.......Good.
CUTTING.............Cut over on road east of Pactola, along Rapid Creek, and on limestone divides.
YIELD.................In Victoria Gulch, 5,000 to 6,000 feet per acre; elsewhere, uncut areas, 2,500 feet; cord wood, 10 to 15 cords per acre.
TRANSPORTATION.....Best timber remaining is very difficult to exploit.

DISTRICT NO. 42.—WILD IRISHMAN GULCH.

ROCK.................Slate and limestone.
SOIL..................As in preceding.
FOREST...............Along Rapid Creek, as in preceding. In lower limestone section forest is open and chiefly young growth. There is little merchantable timber.
DENSITY..............0.4.
REPRODUCTION.......Poor.
FIRE..................Flat limestone plateaus severely burned at different periods.

DISTRICT NO. 43.—DEER CREEK.

ROCK.................Slate and limestone.
SOIL..................On bottom lands a fresh clayey loam; on slopes, thin.
HUMUS...............Half inch.
FOREST...............Large part of area culled of merchantable saw lumber. What remains is 12 to 16 inches in diameter on an average, the larger trees being mostly defective or scrubby. Between Pactola and Merritt there is a large amount of second growth of various ages. Box elder, aspen, hazel, elder, etc., occur.
DENSITY..............0.5 to 0.6.
REPRODUCTION.......Good.
CUTTING.............Chiefly cut within the last fifteen years by T. J. Elliott.

DISTRICT NO. 44.—BEAR GULCH.

ROCK.................Slate.
SOIL..................On slopes, thin and stony; in ravines, rich fresh loam.
HUMUS...............One-half inch. Soil grassed over near Rapid Creek.
FOREST...............On slopes, open stand of pine 12 to 18 inches in diameter, for the most part rather short and scrubby and very unsound, especially on south slopes. In side ravines, a broken forest of veterans averaging about 20 inches in diameter, mixed with patches of younger timber just coming to merchantable size and second growth of various ages. Along creek, spruce, aspen, elm, box elder, and many shrubs.
DENSITY..............About 0.5.
REPRODUCTION......Near Rapid Creek, poor; at high elevation, excellent.
DEAD TIMBER........About 3 per cent.
FIRE..................Old fires did great damage to timber. Probably 50 per cent of old timber burned at butt.
YIELD.................In better portions, 5,000 feet per acre; on an average, about 3,000 to 4,000 feet per acre. Cord wood, about 15 cords per acre.
TRANSPORTATION.....Road up Bear Gulch. A large part of timber at present difficult to exploit.

DISTRICT No. 45.—NUGGET GULCH.

ROCK .... Slate.
SOIL .... As in Bear Gulch.
FOREST .... At head of creek there is a good body of old timber averaging about 20 inches in diameter with long clear stems and fairly sound, mixed with patches of poles not large enough for lumber. At lower end of creek mostly cleared by fire and area grassed over, except in some protected ravines. Spruce, aspen, and willow abundant in ravines.
DENSITY .... 0.5 on timbered area.
REPRODUCTION .... Excellent at head of district.
CUTTING .... Some timber cut on Rapid Creek for mining purposes.
FIRE .... High ridges above Rapid Creek have been stripped by old fires; at head of district old trees show injury at butt.
YIELD .... At head of creek, 5,000 feet per acre. Very difficult of access.

DISTRICT No. 46.—JENNY GULCH.

ROCK .... Slate.
SOIL .... As in preceding.
HUMUS and LITTER ... Light.
FOREST .... Very much broken by fire. What merchantable timber remains is in small patches at the heads of side ravines. Greater portion of area covered with scattered fire-scarred veterans mixed with second growth of various ages.
DENSITY .... 0.4.
REPRODUCTION .... Good.
CUTTING .... Cut out along road on Jenny Gulch by the Comstock Mill, which is still in operation. About 80 per cent lumber removed on cut-over land.
YIELD .... In untouched forest, about 2,000 to 3,000 feet per acre of saw lumber. Timber rather difficult to exploit.
FIRE .... At least one-half of old trees have received injury by fire.

SLATE CREEK.

Slate Creek rises at the foot of the Limestone Range in a nearly level and rolling country. The formation is chiefly schist. The general course of the stream is northeast. Through the greater portion of its course the stream flows in an open valley with low rounded hills on each side. Just before reaching Rapid Creek, into which it empties, it breaks through a belt of harder slates and enters a narrow canyon with high ridges on each side.

At the very head of the creek there is a fine body of timber. This timber is interrupted by Gillette Prairie, and a short distance below is terminated by Slate Creek Prairie. The trees are, on an average, 18 inches in diameter and 75 to 80 feet high and have a fine clear length. They are in many cases scarred by old fires, and the forest is interspersed with patches of young timber, some about 100 and some about 50 years old. Recent fires have not done much damage. The lower part of the region above the canyon has been very severely culled. Not only has the merchantable timber been removed, but the forest has been literally stripped off for mine timbers and cord wood.

There is still some old timber left in the ravines and on the slopes at the lower portion of the region, where it is difficult of access. Here, too, is a considerable amount of small timber, chiefly about 100 years old, some younger. It is estimated that this portion of the region contains 5,000,000 board feet, besides 30,000 cords not suitable for lumber. At the head of the creek there are about 27,000,000 feet of lumber and 100,000 cords of standing wood, 33 per cent of which is suitable for mine timbers. This makes a total yield of 32,000,000 board feet of lumber and 350,000 cords of wood not suitable for the saw.

The following measurements were taken near the head of the creek:

Sample plots studied in Slate Creek region.

No.	Merchantable trees.		Other trees.		Board feet.	Cord wood.	Tops.	Dead trees.		Area.	Place.	Density.
	Number.	Average diameter.	Number.	Average diameter.				Number.	Cords.			
		In.				*Cords.*	*Cords.*			*Acres.*		
51	16	18	30	11	3,600	5	5.0	5	2.5	1	Gillette's....	0.4
52	21	17	52	13	4,200	12	6.0	2	1.0	1	.....do......	0.6
53	0	0	12	15	0	5	0.0	0	.....	½	.....do......	0.2
54	17	17	21	13	3,400	5	5.0	2	1.0	½	.....do......	......
55	7	15	58	11	700	9	1.0	7	2.5	1	.....do......	0.4
56	12	18	31	15	2,600	10	4.0	0	0.0	½	.....do......	0.5
57	3	14	60	9	300	5	0.5	1	0.5	½	.....do......	0.7

Most of the lumber has been cut out by the Fish & Hunter Lumber Company, and the mine timbers and cord wood chiefly for the Homestake mine. There are about 10,000 acres almost entirely stripped of the forest cover, and 1,000 acres where the lumber only has been taken out.

There are 15 ranches in this district. The soil is productive clayey loam, and heavy crops of oats and potatoes are obtained from it.

CASTLE CREEK.

Castle Creek is the south fork of Rapid Creek, and is formed by three separate branches, which deviate at a wide angle and drain a large area. The north branch, commonly known as Reynolds Creek, heads south and within a few miles of Crook Tower, in a very elevated portion of the Limestone Range. The middle fork heads at about the same elevation, nearly 7,000 feet above sea level. The north fork rises among the shallow swales which are so characteristic of the limestone region, and, in the torrential portion of the stream, cuts through a deep gorge, with steep, often precipitous, slopes rising 500 to 1,000 feet on each side. The valley widens out as it approaches the middle fork and comes into the micaceous schist formation. The middle fork of main Castle Creek flows through a deep but rather broad valley. The side streams have cut the limestone into singularly regular cliffs and buttes, which at a distance resemble veritable castles. From these castellated peaks the stream has derived its name. Pl. XXXII, *A*, shows a characteristic butte. After emerging from the limestone formation the valley opens out and the hills are low and rounded, and here there is a large amount of rich agricultural land. Some miles below the limestone a formation composed of hard argillaceous slate and hornblende is encountered, and here the stream again enters a narrow canyon, with high rugged cliffs and steep precipitous slopes, broken by innumerable deep side ravines and canyons.

The south fork rises also within the limestone formation, at an elevation of 6,500 to 7,000 feet. There are numerous ramifications, which have cut the limestone into ravines, which at the upper portions form grassy parks and below run into narrow ravines and canyons. As was the case with other branches, the valleys open out as soon as the soft schist formation is encountered.

At the head of the north fork there is a great second-growth pine forest, about 100 years old, dating from old fires. This forest is broken by innumerable parks, which follow the shallow ravines near Crook Tower. At high elevations near Crook Tower the pine forest is indiscriminately mixed in certain places with spruce. Where the stream enters the deeper ravines the spruce runs a short distance up the north slopes and follows the streams on the bottom of the canyons. On the ridges pine grows to the exclusion of other species. On the canyon bottoms and lower slopes which have been burned over aspen forms the principal part of the second-growth forest.

The greater portion of the pine within the Limestone Range is about 10 to 14 inches in diameter. Some trees are as large as 18 inches, but they are usually too knotty for lumber. The forest has an average density of about 0.7. The growth is rapid, and many trees are covered with persistent branches. They are about 60 feet high. Along the edge of many parks and on the lower slopes of canyons there are frequent patches of old veterans, and sometimes for a long distance there is a fringe of old trees on each side. They are in every case badly scarred by fire. By their protected position they have escaped destruction from fires, and have probably been the chief seed trees from which the present forest has come.

The middle fork has been much more severely burned than the north fork. On the north slope, near the head of the stream, there are considerable patches of mixed pine and spruce, the latter predominating. On the high, flat divides, especially south of the creek, enormous areas have been absolutely stripped of the forest by fires. The reproduction is exceedingly poor, and the straggling growth which is at present

A. CHARACTERISTIC VIEW IN THE LIMESTONE PORTION OF CASTLE CREEK.

B. A BRANCH OF CASTLE CREEK, SHOWING THE CHARACTER OF THE COUNTRY IN THE SCHIST FORMATION, WITH LIMESTONE BUTTES RISING IN THE BACKGROUND.

found upon them consists of patches of aspen and scattered individuals and patches of pine about 20 to 25 years old. Pl. XXXIII, *A*, shows the character of this burnt country.

On the south fork, and especially on the south branches, there is a large amount of dense pole woods, and within the ravines and canyons there is still a fair amount of scattered old timber. On Haley Creek is found a body of fine merchantable timber, and near Mountain City there is a large body of old timber, severely injured by fire, and mixed with second-growth poles. This region will yield about 4,000 feet to the acre. The following valuation surveys give us an excellent picture of this old forest.

Sample plots studied in Castle Creek region.

No.	Merchantable trees.		Other trees.		Board feet.	Cord wood.	Tops.	Dead trees.		Area.	Place.	Density.
	Number.	Average diameter.	Number.	Average diameter.				Number.	Cords.			
		In.		*In.*		*Cords.*	*Cords.*			*Acres.*		
51	8	20	33	13	5,000	8	7.5	2	1.5	1	Mountain City ...	0.5
60	8	16	19	12	1,100	4	1.5	4	2.0	½	.....do	0.4
61	8	16	28	14	1,100	8	1.5	0	0.0	½	.....do	0.5
62	3	18	33	14	750	9	1.0	1	0.2	½	.....do	0.5

Between Mountain City and the north fork, within the schist formation, there is an extensive prairie known as Reynolds Prairie, which has no tree vegetation whatever, but is used extensively for stock raising and farming. Within this formation there is again encountered a large amount of old timber. In the side ravines, on the lower slopes and bottoms, the timber averages about 4,000 to 5,000 feet to the acre. On the high slopes and ridges the timber is small and scrubby, and everywhere within the region there are patches of second-growth timber about 100 years old. The old timber is considerably injured by ancient fires, and on the slopes and ridges a large proportion of the trees are unsound. Dense patches of spruce follow the creek, which reach a height of 100 feet and a diameter of 2 feet.

It is estimated that 19.8 square miles within this area are covered with first-growth timber, with an average yield of 3,000 feet per acre; that 101 square miles are covered with a second-growth forest about 100 years old, yielding on an average 15 to 20 cords per acre, and that 40 square miles are totally cleared or are covered with a straggling second-growth of saplings. The total yield is estimated at 50,000,000 board feet of lumber and 1,200,000 cords of other timber. Among other vegetation of interest found in this region may be mentioned the dwarf juniper, which is abundant in the limestone; white birch, often found on the edges of limestone cliffs, and several specimens of red cedar, seen on exposed hornblende peaks. Within the spruce forest the character of the undergrowth is completely changed from that within the pine forest. Here we find moss, Chimaphila, Vaccinium, and bunchberry. The characteristic undergrowth of high limestone cliffs is the Ceanothus, Oregon grape, and Saxifraga, in addition to the common forest plants found everywhere.

But a small portion of this region has been encroached upon by the lumbermen. Near Castleton about 500 acres have been cut over within the last five years by the Fish & Hunter Lumber Company. The best saw lumber only was taken, and the present forest is composed of defective trees and thrifty poles and has a total density of about 0.5. Elsewhere the cutting has been confined to the timber used by miners and ranchers.

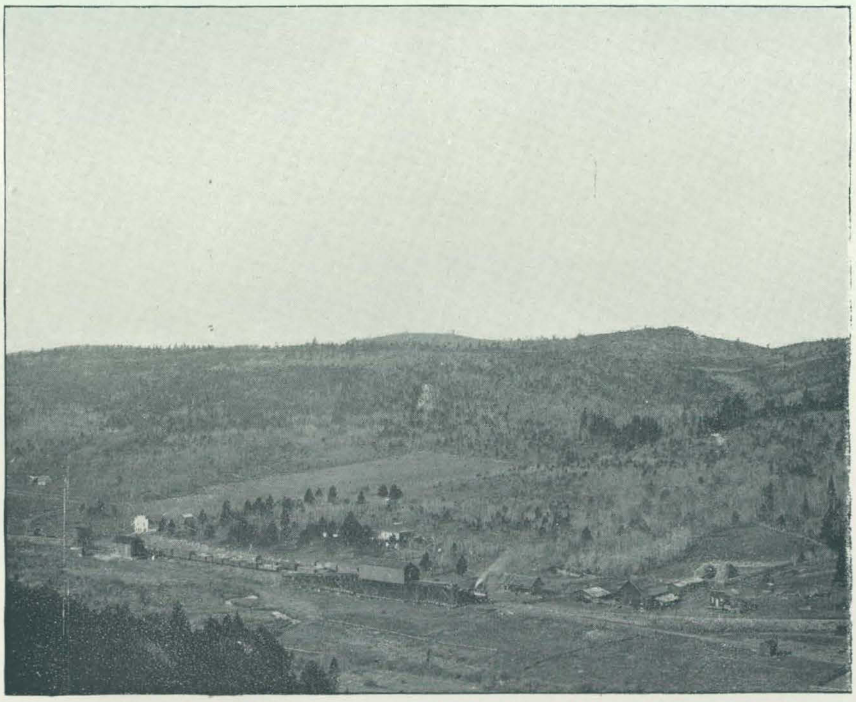
This region has been badly injured by repeated fires at the extreme western end. The fires burned severely over the whole region, but on account of the broken character of the slate formation the timber suffered less than in the limestone and on the rolling hills of the schist formation.

There are 22 ranches, including those which have been taken up within the last year. All the open land which is suitable for agriculture has already been located. There is, however, along the lower part of Castle Creek a considerable amount of rich bottom land which is covered with a dense growth of spruce, willow, aspen, and shrubbery, which, if cleared, would be suitable for agriculture. It would form, however, a very narrow strip. In all bottom lands the soil is exceedingly rich and produces whatever the climate will permit. Oats, potatoes, and timothy form the chief crops. At the very high elevations ranching is still an experiment.

On the lower part of Castle Creek there is at present considerable mining on a small scale. There is still some placer mining. New mines are being developed in the vicinity of White Weasel Gulch, and there is a large amount of prospecting, not only in the lower portions of the region, but also in the limestone.

Stock raising is not carried on to a very great extent in this region. Each rancher usually owns a small bunch of horses and a few cattle. On Reynolds Prairie there are probably altogether about 300 to 400 head of stock, including horses and cattle. Throughout the limestone, and the greater part of the rest of the region, there is a luxuriant growth of excellent grass. In the limestone, however, the elevation is so great that it is suitable only for summer grazing, and in the lower part of the region the country is too rugged for stock.

A. BURNT LAND IN THE LIMESTONE.



B. CUT-OVER LAND AT ENGLEWOOD, SOUTH DAKOTA, SHOWING THE SCANT REPRODUCTION ON LAND WHICH HAS BEEN ENTIRELY STRIPPED OF TIMBER.

DISTRICT NO. 48.—HEAD SOUTH FORK.

ROCK .... Limestone.
SOIL .... Thin and in many places stony.
HUMUS................ Half inch.
LITTER................ Medium.
FOREST .... Chiefly a forest of poles about 100 years old, 10 to 14 inches in diameter and 50 to 60 feet high, mixed with patches of 50 to 60 year old low poles, and in some ravines scattered fire-scarred veterans. Forest much broken by open parks which follow shallow ravines. Trees mostly covered with small, brittle branches nearly to ground. Considerable spruce on north slopes and in canyons.
DENSITY .... 0.7.
REPRODUCTION....... Poor.
FIRE .... Severe fire in 1881, 1891, and 1894.

DISTRICT NO. 49.—HALEY CREEK.

ROCK .... Limestone and schist.
SOIL .... On ravine bottoms, deep, fertile loam; on ridges and slopes, thin.
HUMUS................ Half inch.
LITTER....... .... Medium.
FOREST .... On Haley Creek and near Mountain City a forest of veterans 20 to 22 inches in diameter, mixed with patches of 100-year-old poles 10 to 14 inches in diameter and 50 to 60 feet high. Old timber badly fire scarred and, in places, unsound. Remainder of forest is a second-growth pole forest about 100 years old, with occasional old trees. In northwestern portion there is a large tract of burnt land either bare or covered with a straggling growth of young pine and aspen. Scattered spruce occurs along creeks.
DENSITY .... 0.6.
REPRODUCTION....... Very good except on large burnt areas.
FIRE .... Old fires did great damage in entirely clearing considerable tracts and injuring the standing timber.
YIELD.................. In greater portion of old timber, 3,000 to 4,000 feet per acre. Cord wood, 10 to 15 cords per acre. Timber not difficult to exploit.

DISTRICT NO. 50.—REYNOLDS PRAIRIE.

ROCK .... Schist and limestone.
SOIL .... Mostly grassed over.
FOREST .... Greater portion of area open prairie. On edge of limestone, open second growth. On a portion of Castle Creek, fire-scarred veterans mixed with second growth.
REPRODUCTION....... Poor.

District No. 51.—Head Castle Creek.

Rock ....Limestone and sandstone.
Soil ....Rich, deep loam on bottom lands.
Humus ....Greater part of area grassed over.
Forest ....Broken stand of second growth about 30 to 60 years old, and about 100 years old, with patches of fire-scarred veterans, the latter in protected ravines. South of creek mostly burned and covered with straggling saplings of pine and aspen. On north slopes and in canyons spruce about 12 inches in diameter abundant; along creeks white birch and willow.
Density ....In 100-year-old pole forest, 0.7; in 30 to 60 year old forest, 0.3.
Reproduction........Poor.
Fire..................A large part of district cleared by old fires. Recent fires chiefly on flat ridges.

District No. 52.—Reynolds Creek.

Rock ....Limestone.
Soil ....Thin and stony, except on ravine bottoms.
Humus ....In dense woods, good; on slopes, poor; in open woods, grassed over.
Forest ....For the most part an even-aged stand of poles about 100 years old and 10 to 14 inches on an average, mixed with patches of old timber along the edges of parks. In many places broken by fire and the blanks filled with young growth. Spruce abundant in canyons and at head of creek. Aspen, birch, and willow grow in profusion. Many patches of timber killed by insects.
Density ....0.7.
Reproduction.......Excellent.
Fire..................Greatest damage by fire done many years ago. Little injury by recent fires.
Yield.................15 to 20 cords per acre.

District No. 53.—Castle Creek.

Rock ....Slate.
Soil ....Stony and thin except on bottom of canyons.
Humus ....Half inch.
Forest ....A veteran forest of pine 20 inches on an average and about 70 feet high, with clear stems of about 25 to 35 feet, mixed with patches of second growth about 100 and about 50 years old. Best timber in side ravines. Along creek, spruce 12 to 18 inches, aspen, birch, and willow.
Density ....0.6.
Reproduction...... .Good.
Dead timber.........0.5 per cent. Large proportion of trees unsound.
Cutting ....Lumber removed on Pony Gulch, and forest severely cut along railroad south of Castleton.
Fire..................About one-half the old trees are injured by old fires. Severe fire in 1893 near Gayers Gulch.
Yield.................2,000 to 3,000 feet per acre.
Transportation.....Most of the timber difficult of access.

LITTLE RAPID CREEK.

This region comprises a drainage area of 100 square miles. The creek is formed by two streams which meet at nearly right angles about 6 miles from Castle Creek. The north branch rises in the Dumont divide, in the limestone formation, and flows through a broad and productive valley. The south branch rises near Crook Tower, among the open parks of that region, and has cut a deep canyon through the edge of the limestone, which broadens out as soon as the schist formation is reached. The valley becomes narrower where it meets the north fork, as the formation changes from schist to harder slate and hornblende. The soil in the limestone section is a rich, fresh, compact calcareous clay. On the flats and bottoms of the ravines the soil is deep and very productive for any crop which can be raised in the climate. There are many bare limestone buttes with steep stony slopes, which, when once cleared, are reforested with great difficulty. In the Archean section the soil is, on moderate slopes and bottoms, a clayey loam, fairly deep, fresh, rich, and productive; on the steep slopes, stony and thin. This section has received its present form by the erosion of the soft slates and schists, leaving the hard rocks standing out in rugged peaks and ridges.

About 36 per cent of the area is covered with forest; the rest has been cleared by fire or by the ax since white men first came into the country. The portions cleared by fire are either devoid of tree vegetation or are covered with a scattered growth of young pines, aspens, shrubs, grass, and herbs. At the head of the creek, especially on the north slopes, there are a number of patches of nearly pure spruce. Below the limestone formation spruce is found on the bottoms of the canyons along the streams. It attains a diameter of 2 feet and a height of nearly 100 feet. It has a quick taper, a long crown, and very knotty timber, and within this section rarely finds any use. It grows dense, but the branches are exceedingly persistent, and all trees which attain a large size are very scrubby. Aspen is abundant over the whole region. It springs up after fires on fresh soils, in depressions and ravines and on north slopes. It is generally 3 to 6 inches in diameter and 20 to 30 feet high. It is used in this region for fence poles, bridge coverings, rude camps, and, when dry, for fuel.

The main body of timber is an exceedingly broken forest of yellow pine, with only about 50 per cent of veterans, and the rest a second growth about 100 years old. The old pine is, on an average, 20 inches in diameter and 75 feet high; the young pine about 12 inches on the stump. There are many patches of young timber about 50 to 60 years old, and often patches of small saplings and seedlings. The scattered veterans are found on the edges of the ravines or in patches where the configuration of the land was such that the fire did not seriously injure them. The second-growth timber, often called jack pine and scrub pine, is in many cases covered with branches which are weak, brittle, and easily broken off. If this timber is allowed to remain, many of the trees will clear themselves of branches and form fair lumber. The second growth has an average density of about 0.7, the veteran forest not more than 0.4 or 0.5. The best bodies of old timber are on the south branch, not far above the ranch of Buchholz & Green, and on Gimlet Creek. It is estimated that altogether there are standing 30,000,000 feet of merchantable saw timber. There are, besides this, 350,000 cords suitable for mine timber and cord wood. The undergrowth is composed of bearberry, scattered snowberry, strawberry, service berry, Spiræa, Sheperdia, Sedum, and various Leguminosæ. Where breaks occur herbs of all kinds spring up, and in the rich bottom lands dogwood, hazel, thorn, willow, and innumerable weeds form the undergrowth. In the limestone there is a luxuriant growth of grass and weeds.

Few districts have suffered more from fire than this. The great fire about one hundred years ago swept off a vast amount of timber, especially in the northern part. The configuration of the lower part of the region prevented a considerable portion of the timber from being destroyed. The fire about fifty-five years ago burned with great severity in this region, and in all probability the fire of twenty-five years ago again swept through the same section. Much of the old timber which remains was badly injured by these fires. Scores of trees were so burned at the butt that they are broken by the wind. In some places 50 per cent of the trees show injury by fire. Recent fires have been frequent throughout the region, but have done less damage than the old fires.

The principal industries of the region are mining and farming. There are 5 stamp mills within the region—2 at Rochford, 1 at Gregory, 1 at Meyersville, and 1 at the Minnesota mine. Of these all but two are idle. There are a large number of prospects being developed on which assessment work is being done. The water in the creek is turned near Gregory and near Rochford for milling purposes. There are 15 to 20 ranches within the region. Oats and potatoes are the chief products and are consumed for the most part by the ranchers themselves. A small amount of stock owned by the settlers range over this region.

Most of the accessible merchantable timber near the railroad has been cut out. The timber near the ranches has been more or less cut over for local uses, and near mining claims poles have been cut for shafts and cabins. Along the railroad there has been a good deal of timber cut for ties. About 22 square miles have been cut over for lumber. Three years ago a large amount of timber was cut near the railroad, about 2 miles north of Castle Creek, the trees cut into logs and left in the woods. A sawmill is now being built at the mouth of Gimlet Creek to cut the lumber in that section. The merchantable timber near Bulldog ranch was cut several years ago, and the Homestake Company is now cutting over this section for mine timbers. Some mine timbers are also being removed from Bloody Gulch. The local demand for fuel is supplied almost entirely from dead timber. There is some cord wood shipped to Deadwood. The entire region is well cut up with roads, so that the removal of what merchantable timber remains is simple.

DISTRICT NO. 54.—BLOODY GULCH.

ROCK .... Chiefly slate.
SOIL .... On slopes, thin and stony; on ravine bottoms, rich loam.
HUMUS and LITTER... In second-growth forest, good; elsewhere, scant.
FOREST .... Larger part of accessible saw timber removed. What remains is 14 to 16 inches in diameter and about 60 to 70 feet high, mixed with second-growth about 100 years old. Some patches of untouched timber in less accessible localities. Large tracts cleared by old fires and now coming up to aspen and scattered pine. Spruce along creeks.
DENSITY .... In forest, 0.5.
REPRODUCTION....... Very good except on large burns.
FIRE .... Great injury by old fires, and many square miles cleared. Surface fires have been frequent.
CUTTING .... Along railroad for ties; at western end for lumber and mine timbers. Of the saw lumber 75 per cent has been removed.

DISTRICT NO. 55.—HEAD IRON CREEK.

ROCK .... Limestone and schist.
SOIL .... Bottom lands, productive loam; slopes, stony; large proportion of area grassed over.
FOREST .... For the most part a second growth, about 100 years old in western section and about 50 years old in eastern portion, with patches of original forest in protected canyons. Along lower part of Iron Creek a broken stand of old trees, about 18 inches in diameter, mixed with second growth. Spruce 12 to 24 inches in diameter abundant along canyon bottoms and at high elevations.
DENSITY .... 0.5 at lower end, 0.7 at head of district.
REPRODUCTION....... Good, except near parks.
YIELD .... In original forest, 3,000 to 4,000 feet per acre of saw lumber. At present difficult of access.

DISTRICT NO. 56.—HEAD NORTH FORK.

ROCK .... Limestone and schist.
SOIL .... As in preceding.
FOREST .... A fairly dense stand of poles about 100 years old, mixed with larger trees about 160 years old, and a few veterans. Greater part of saw lumber removed. Spruce in considerable quantities at head of creek. Large burnt tracts in eastern portion. Many parks.
DENSITY .... 0.6 to 0.7.
REPRODUCTION....... Good in western portion.
CUTTING .... Cut for lumber west of Bull Dog ranch. Homestake Company now cutting same area for mine timbers.
FIRE .... Large tracts cleared in eastern portion by old fires.

DISTRICT NO. 57.—MINNESOTA.

ROCK	Slate and schist.
SOIL	On slopes, thin and stony; on bottom lands, fresh rich loam.
HUMUS and LITTER	For the most part poor.
FOREST	For the most part cleared by fire, except in the southeastern section. On Gimlet Creek forest of pine 20 to 22 inches on an average and 70 to 80 feet high, mixed with second growth of various ages. Aspen and birch abundant on fresh soil.
DENSITY	In forest, 0.6.
REPRODUCTION	Good, except on large burns.
CUTTING	Along railroad for ties.
YIELD	On Gimlet Creek 5,000 to 6,000 feet per acre of saw lumber.
FIRE	Old trees injured at butt, and on most of area forest stripped off by old fires.

BOX ELDER CREEK.

Box Elder Creek is formed by the union of a large number of small streams, which rise in a rolling and comparatively level country east and southeast of Custer Peak. These streams are in many cases intermittent, being dry during the greater part of the year. In many places they are lined with rather broad flats, with rich, dark soil, formed by beaver dams. The various forks head in a slate formation and come together in the limestone, forming a rather broad, slow stream, which has cut out a wide valley with rich, productive soil. Below Jim Creek the valley is contracted to a deep, narrow canyon, in which the stream sinks before reaching the foothills.

Wherever there is an extensive area of level country the forest has usually been very severely injured by fire. There is such an area of rolling and nearly level country at the head of Box Elder Creek, and extensive tracts of forest have been swept off by fires at different periods. Upon this area there is a young pine forest springing up, and wherever there are any old trees left to seed up the land the sapling growth is dense. Elsewhere reproduction is slow and the young forest broken and irregular.

As soon as the streams reach the somewhat more rugged and broken country the old timber is encountered, and on the south fork there is found one of the finest bodies of timber in the Black Hills. This timber lies on the South Fork and Jim Creek and covers an area of 16.4 square miles. It is exceptionally tall and clear, with a height of 80 to 100 feet and a clear length often of three 16-foot logs. The average diameter is about 20 to 22 inches, but trees of 3 feet are not uncommon. The soil is unusually deep, well watered, and productive, and reproduction is exceptionally fine. The old timber grows, as a rule, very dense, and for this reason has had a smaller diameter growth than would be expected on such excellent soil. Full compensation is made, however, by the growth in height and the clear, sound character of the timber. This area has not been free from the ravages of fire, and the forest is broken by patches of second-growth timber about 12 to 14 inches in diameter. The second-growth timber has an age of about 100 years, and there is a considerable amount 40 to 60 years old. On the steep slopes and ridges the timber is small and more injured by fire than on the flats and bottoms of the ravines. The total density of the forest is 0.6 or 0.7. On the bottoms of the canyons and ravines are found small bodies of spruce which reaches a diameter of nearly 2 feet. Aspen, white birch, willow, dogwood, hazel, and other common shrubs are abundant along the bottoms of the creeks. On Box Elder Creek box elder, elm, ironwood, chokecherry, and pin cherry were also noticed, as well as such shrubs as hazel, thorn, sumac, nine-bark, wild rose, etc. On a high divide sumac (*Rhus trilobata*) and *Ceanothus ovatus*, as well as a few specimens of red cedar, were seen. The condition of this timber is shown by the following sample plots:

Sample plots studied in Box Elder Creek region.

No.	Merchantable trees.		Other trees.		Board feet.	Cord wood.	Tops.	Dead trees.			Area.	Density.
	Number.	Average diameter.	Number.	Average diameter.				Number.	Average diameter.	Cords.		
		Inches.		*Inches.*		*Cords.*	*Cords.*		*In.*		*Acres.*	
17	38	16	32	10	5,500	3.5	15	2	9	0.2	½	0.8
18	20	22	10	9	8,500	1.2	22	2	15	0.7	½	0.7
19	22	20	6	10	7,000	0.7	15	0	0	0.0	½	0.7

These measurements are taken from the larger and denser old timber. It is estimated that the yield of the whole of the tract above described would be 8,000 board feet per acre. East of Box Elder Creek, on the high limestone divides, fires have done a great deal of injury to the forest, and there are considerable tracts completely stripped of all forest covering. On some slopes and ravines there is still a broken veteran forest of pine, but the density is generally small, and there are many scattered patches of second growth. The forest on Bogus Jim Creek is much broken by fires, and what remains after cutting is chiefly second growth, for the most part about 10 to 14 inches in diameter, but with a considerable amount of younger poles and saplings. The density of this portion of the forest is about 0.6 in the timber limits and 0.5 over the whole area. Back in the ravines at some distance from the creek there is still some saw timber, which is being removed for the Pinkerton sawmill. East of Green Mountain the forest is much broken by fire, and consists chiefly of small, scrubby timber, except in the narrow ravines. It is estimated that 21.8 square miles are covered with old timber suitable for saw lumber. Of this 75 per cent has a yield of 8,000 feet per acre, 14 per cent 2,500 feet per acre, and the remainder about 6,000 feet per acre. This makes a total yield of 95,000,000 board feet. There are, besides this amount, about 1,260,000 cords of wood left on the area. A large part of the latter could be used for mine timber.

Fully 17.3 square miles of this region have been cut over for saw lumber. On main Box Elder Creek a large tract was cut over for saw lumber by Hulz and Price. The trees were cut down to about 14 inches on the stump, and there are fully 40 to 50 trees per acre left which were too small or defective to cut.

A small strip was cut out by M. A. Tipton on South Box Elder near Greenwood, and in one place a large number of logs were found which had been left in the woods. A plot of one-half acre was run out in one place and 31 logs found scattered about on this small area.

The Homestake Company has taken up a large number of claims in this region, and is building a branch railroad to take out the timber. Practically all the good timber has been taken up, either by the Homestake or by sawmill companies within the last year. This land is taken up as mineral land, and in some cases alleged discovery pits dug and assessment work done. The Homestake Company is having ties and mine timbers cut near Greenwood, and is said to have purchased a sawmill near Nemo.

On main Box Elder Creek there are at present three sawmills in operation. One near Nemo, owned at present by Hawk Brothers, and two below owned by T. J. Elliott and McGee Brothers. Another mill, owned by W. W. Pinkerton, is operating on Bogus Jim, and the Price & Baker Company mill at Black Hawk draws upon this region for saw logs. About 1,200 acres were cut over some years ago on Jim Creek near Riley's ranch. South of Jim Creek, on Bogus Jim Creek, the timber has been to a large extent cut over.

There is in this region an unusually large amount of tillable land. The country is comparatively level and the valleys are broad. On main Box Elder Creek there are 15 ranches within the unsurveyed land; on South Box Elder, 4 ranches; 8 on Jim and Bogus Jim creeks, and 14 scattered throughout the region on small streams, making altogether 41 ranches. There is also a large amount of rich land which is now covered with forest and which will eventually be cleared and used for this purpose. The land which has been cultivated is in itself so rich that there is no need of irrigation. The chief products are oats and potatoes and, in a few places, corn. On the divide between Deer and Bogus Jim creeks the experiment of tilling land on the divide has proved successful.

DISTRICT NO. 58.—HEAD NORTH FORK.

ROCK ....Soft slate.
SOIL ....Rich loam in depressions.

FOREST .... Nearly whole area cleared by cutting or burning and covered with a young growth of pine and aspen or entirely bare; what is left of larger timbers is chiefly poles 10 to 12 inches in diameter and about 100 years old.

DISTRICT No. 59.

ROCK .... Chiefly slate.
SOIL .... Rich, dark loam.
HUMUS and LITTER .. Good.
FOREST .... A body of heavy timber averaging 20 to 22 inches in diameter, reaching a maximum size of 3 feet and a height of nearly 100 feet, with a clear length of 2 to 3 16-foot logs, mixed with second growth of various ages. Spruce scattered along creek.
DENSITY .... 0.7.
REPRODUCTION....... Prolific.
FIRE .... Forest broken in a number of places by clearings caused by fire, and trees somewhat burned at butt; little injury from recent fires.
CUTTING .... Near Greenwood, for lumber. On main Box Elder, 3 sawmills now in operation.
YIELD .... 8,000 to 10,000 feet per acre. Timber accessible.

DISTRICT No. 60.—JIM CREEK.

ROCK .... Slate, quartz, limestone, and some quartzite.
SOIL .... On bottoms, rich loam; on slopes, stony and thin.
HUMUS................ Half inch.
LITTER............... Fair.
FOREST .... On Jim Creek heavy timber, similar in quality to that in the preceding. On Bogus Jim Creek chiefly second growth of various ages up to 100 years old, the greater part of the old timber having been removed.
DENSITY .... 0.5 to 0.6.
REPRODUCTION....... Very good, except on limestone hills.
FIRE .... Forest much broken by fire, especially in limestone section; not so much burned on Jim Creek.
CUTTING .... On Jim Creek some years ago, near Riley's ranch. On Bogus Jim, by Pinkerton sawmill.
YIELD .... In old timber, 6,000 feet; cord wood, 10 to 15 cords per acre. On Jim Creek difficult of access.

DISTRICT No. 61.—LOWER BOX ELDER.

ROCK .... Limestone.
SOIL .... Much grassed over.
FOREST .... Much broken by fire. Many large blanks cleared of forest, especially on flat plateaus. Some timber at western end large enough for lumber. Greater portion of area covered with broken forest of small scrubby second growth.
DENSITY .... Very poor.
REPRODUCTION....... Poor.
YIELD .... At western end, 2, 000 feet per acre.
FIRE .... Very destructive fires before white men came into the country, clearing considerable areas of forest cover.

ELK CREEK.

Elk Creek heads in the nearly level country just north of Custer Peak and flows in a general easterly direction, at first through an open valley with low rounded hills, and below through a narrow valley which becomes a deep canyon when the limestone formation is reached. This creek, like Box Elder, finally sinks in the limestone.

There is but little timber left in this district, and that is confined to the ravines and canyons at the lower part of the timbered portion of the stream. The railroad owned by the Homestake Company runs through this valley and has cleared off all the timber at the head of the creek and culled out almost everything which could be used within the reach of the railroad. In the deep, more inaccessible ravines and canyons there is still some lumber left, but this is being rapidly removed for timbers by the Homestake Company, and for lumber by the various sawmills in that section. There are said to be three sawmills on Little Elk Creek—two owned by George Runkel and one by Pratt—and one at the settlement of Runkel, on main Elk Creek.

It is estimated that 75 square miles of the merchantable timber have been culled. It is estimated that there are about 10,000,000 board feet scattered in the ravines and canyons of this district, and about 250,000 cords of wood.

A great fire ran over the district at the head of Elk Creek in 1893, destroying a vast amount of young timber and killing almost everything as far as Runkel.

There are between 45 and 50 ranches within this district. It is one of the most important farming sections of the Black Hills.

BEAR BUTTE AND WHITEWOOD CREEKS.

These two streams drain the northeastern section of the Black Hills. The former rises in the nearly level country north of Custer Peak and has a northeasterly course. About 4 miles from its head it enters a narrow valley with high, abrupt slopes, which opens out just before reaching the limestone formation. Through the limestone ridge in the foothills it has cut a deep canyon.

Whitewood Creek heads on the northern side of the high Dumont divide northwest of Custer Peak at an elevation of about 6,000 feet. It rises in the limestone formation, but cuts through a belt of slate and igneous rock and sinks before reaching the limestone in the foothills. At its head the country is comparatively level, but near Sugar Loaf Peak the valley becomes contracted to a deep gorge hemmed in by high, rugged ridges and peaks.

There is practically no merchantable timber left in the entire area drained by Whitewood Creek. Some young growth, about 15 to 20 years old, is coming up in different places, especially on low slopes, and if the fires are kept out there will in time be an excellent growth of timber. It is estimated that about 30 per cent of the Whitewood district is covered with fairly good young timber. Over the rest of the area there is either no young growth or it is very scattered.

Aspen forms, in many places, an important element in the young forest, and there is also some white birch. On the east side of the creek, near Crook City, there is a small body of timber averaging about 12 to 14 inches in diameter, but none large enough for saw logs.

The forest has also been entirely stripped off at the head of Bear Butte Creek. About 2 miles above Galena the forest again begins. This timber is about 15 inches in diameter on an average and 60 feet high. It runs about 1,000 feet per acre. There are approximately 40 square miles in this section still covered with forest. It is estimated that in the whole region there is not over 10,000,000 board feet fit for saw lumber. In the limestone portion of the region the forest has been severely culled to supply Sturgis, and near Galena lumber and props have been cut to supply the town. There are still a large number of trees 8 to 12 inches in diameter on the high ridges and slopes, and in some of the more inaccessible localities there are trees large enough for saw logs. The choppers, however, are penetrating even into such places, and on high ridges the timber is being cut off for wood. At the edge of the foothills the timber is young and scattered.

The great bulk of the timber which has been cut from these regions was removed by the Homestake Company. At the time this was cut a large amount of cord wood was consumed and everything was taken that could be utilized. While this system of clear cutting had the advantage of utilizing all the material cut, such a large area was cut over that the reproduction has been for the most part very poor. There are at present three sawmills which draw upon this section for saw logs.

These regions have suffered severely from fire, and the country about Terry Peak has been repeatedly burned. North of Deadwood, between Whitewood Creek and the ridge east of False Bottom Creek, the forest has been entirely killed by recent fires. There are also extensive burns near Sturgis. The fire of 1893 destroyed a vast amount of fine second-growth timber at the head of Bear Butte Creek.

The total amount of standing timber is estimated at 10,000,000 feet of lumber and 200,000 cords of other timber.

The chief industry of the region is mining. The largest mines in the Black Hills are in this section, and it is safe to say that two-thirds of the population are employed in connection with mining. The great mining center is Deadwood and Lead, and the surrounding towns—Gayville, Pluma, Terraville, Terry, Central, Springtown, and Garden—have been built up about the mines operated in these places Galena is a thriving mining town, and the discovery of mines on Two Bit Gulch has turned the miners in that direction. There are important mines at Ragged Top, and throughout this whole section miners are busily engaged in prospecting and developing discoveries.

The amount of agricultural land in this region is small and is confined to the heads of the creeks and the places where the side streams meet Bear Butte Creek. There are said to be 8 ranches on Whitewood Creek and 9 on Bear Butte within the timber limits.

SPEARFISH CREEK.

Spearfish Creek is one of the largest and swiftest streams in the Black Hills. It drains an area of 200 square miles and flows in a northerly direction. Its main branch heads just north of Crook Tower, in the high Limestone Divide, among the shallow ravines and grassy parks of that region. Nearly the whole length of the stream is through a limestone formation, and it has cut out a deep canyon with steep, abrupt slopes, which rise a thousand feet and more on each side in the deepest portion. The entire region is well watered and numerous branches enter the main creek through deep canyons. The largest branch is the Little Spearfish Creek, which meets the main fork about 12 miles from the mouth of the canyon. Above the canyon are extensive areas of rolling and nearly level country, broken into broad ridges by the numerous ravines and canyons which are tributary to the main creek. Near the mouth of the canyon the stream breaks through a narrow belt of slate and igneous rock and a short distance below again enters the limestone formation. After emerging from the canyon, the stream flows through a broad, rich, productive valley and is lined with prosperous ranches. The canyon and side ravines are so narrow, and in many cases are covered with so thick a growth of spruce, birch, willow, etc., that in but a few cases has any attempt been made at cultivating the land.

The high mesas of this region are comparatively level and rolling and of such great extent that fires are able to attain great proportions. This entire country has been burned at different periods. The fire of about one hundred years ago seems to have burned over the entire area, doing especial damage about the region drained by the south fork, and at the present time this area is covered almost entirely with a second-growth forest dating from about that time. The veteran forest near the mouth of Spearfish Canyon is broken by patches of second growth of about the same age. The northern portion of the region has been severely injured by later fires, and the forest is now broken by patches of young timber of various ages. Judging from the young growth which is springing up on the most severely burnt areas, fires about twenty-five years ago swept through the country about Terry Peak and Elk Mountain, crossing the canyon and burning over the lower part of Little Spearfish and Iron creeks. There are about 61 square miles which are practically devoid of any timber whatever, or covered with a more or less scattering growth of young pines 15 to 20 years old. The most severely burnt area is on the lower portion of

Little Spearfish and Iron creeks and on the eastern side of the main canyon, about the peaks and flat limestone divides near Elk Mountain.

At the head of the main creek, near Crook Tower, and on the high divides at the head of the side ravines the forest is broken by grassy parks which follow the shallow swales. The high mesas in this portion of the region are covered with a second-growth forest 100 to 120 years old, which has an average density of about 0.7. This young timber averages about 12 inches on the stump and is 50 to 60 feet high. On rich soils it is 16 to 18 inches in diameter and 60 to 75 feet high. These trees are especially tall and of fine quality on the slopes of the canyon above the Spearfish crossing. At the head of some of the side ravines there are patches of merchantable timber averaging 20 inches in diameter. Along the slopes of the canyon, where the country is rugged and broken, some old timber still remains, presumably because in those places there was so little material for the fire to burn that the timber was less injured. There is some old timber on the north side of the canyon, near the Spearfish crossing, but this is being rapidly removed. Below Anna Creek there is a small body of good timber which is being manufactured into lumber by the sawmill now operated at that point. About 5 miles below the point where Little Spearfish Creek enters the canyon the old timber again begins, and on Squaw Creek and on slopes and divides west of the canyon there is a fine body of original forest. It is broken by patches of second growth of various ages, but is nevertheless one of the finest bodies of timber left in the hills. On the high divide west of McQuaig's ranch, at the headwaters of Little Spearfish, is another strip of heavy timber. This old timber has an average diameter of 20 to 22 inches, and back from the canyon, in rich ravines, trees 3 feet in diameter are frequently found. This forest has a density of about 0.5. In the portions where the timber is fairly dense there is an average yield of 7,000 feet per acre. There are about 28 square miles covered with old forest, of which 16 square miles have an average yield of 4,000 feet and 12 square miles a yield of 5,000 feet per acre. The reproduction throughout this entire forest is remarkable, and there are but few places in the Black Hills where the young timber comes up in as dense masses as on the north slopes in this region. The reproduction on the large burnt areas, on the other hand, is exceedingly poor.

Within the canyon there is a considerable amount of spruce. At the higher elevations it grows fairly dense on the northern slopes, and it follows the canyon bottom nearly the whole length of the timbered portion of the stream. It grows as high as 100 feet and attains a maximum diameter of nearly 3 feet. But here, as elsewhere, it is so covered with branches as to be unfit for saw lumber. It is used for mine timbers. Sometimes oak is found as a shrub on the high divide west of the canyon, and scattered trees occur within the canyon 8 to 10 inches in diameter and about 35 feet high. There is a small amount of sapling elm, box elder, and ironwood, and a few specimens of the narrow-leaf cottonwood were noticed. Note was made of elder, hazel, dogwood, cherry, and willow. White birch and aspen occur in large quantities on burnt areas, especially at high altitudes. On the divides the common juniper, Oregon grape, and Ceanothus were noted, besides the usual vegetation found throughout the hills. The forest about Crow Peak is a broken stand, composed for the most part of second-growth timber, but with scattered old trees 18 to 20 inches in diameter.

The following measurements were taken in the original forest:

Sample plots studied in Spearfish Creek region.

No.	Merchantable trees. Number.	Merchantable trees. Average diameter.	Other trees. Number.	Other trees. Average diameter.	Board feet.	Cord wood.	Tops.	Dead trees. Number.	Dead trees. Cords.	Area.	Place.	Density.
		In.		*In.*		*Cords*	*Cords.*			*Acres.*		
73	9	19	6	17	2,200	2.8	1.2	1	0.5	½	Spearfish Creek ..	0.4
74	4	17	42	12	800	8.4	1.2	1	0.5	½	.....do	0.5
75	14	20	22	15	3,500	7.5	5.2	1	0.5	½	.....do	0.5
76	9	22	10	11	3,000	1.5	4.2	5	2.0	½	.....do	0.4
77	18	21	33	12	4,500	6.5	6.5	1	.....	½	Iron	0.7
78	21	21	39	13	5,200	9.5	7.5	1	.....	1	.....do	0.7

The total stand of saw timber is estimated at 150,000,000 board feet of lumber, and the remaining timber at 1,300,000 cords.

Along the road from Englewood to the Spearfish crossing the entire area has been denuded of the forest cover and the timber used for cord wood and mine props. At the Spearfish crossing there was, two years ago, a sawmill which cut over an approximate area of 250 acres. Loggers are at present busy cutting out mine timbers and cord wood in the main canyon just above Spearfish crossing, as well as on the slopes for 2 or 3 miles below the crossing. The Boutell sawmill is operating near Anna Creek. The entire forest along the canyon has been culled for ties to build the railroad from Deadwood to Spearfish. There is a sawmill at Spearfish and another one in Higgins Gulch at the foot of Crow Peak. The timber has been culled out for lumber along the road from Bear Gulch to Spearfish, chiefly to supply the sawmill which stood on Sawmill Gulch, but which is now no longer in operation. An approximate area of 12 square miles has been cut over. In some places the mine timber is cut to about 5 inches on the stump to furnish 3-inch flats. The timber is very severely culled when such small timber is utilized. Under ordinary lumbering a comparatively small percentage of timber is removed.

The only industry of any consequence within this region is mining. There are scattered through the region, especially in the country about Terry and Carbonate, numerous mining camps. Throughout this section the people are busy prospecting and doing assessment work. There are at Carbonate two stamp mills, which are not in operation. A great deal of the country all along the canyon has been taken up in quartz claims, and probably a good deal of this has been taken up more for the timber than for mining purposes.

There are 6 ranches in this entire region. Of these 3 are on the south fork, 1 on Little Spearfish Creek, and 2 on the Bear Gulch road. There is a road a few miles up the Spearfish Canyon, and the whole length of the canyon above Elmore. Between Elmore and the lower road there is no wagon road, but the railroad enters the canyon a short distance above Elmore and timber may be transported by that means. The timber on the high divide west of the canyon is, in large part, difficult of access; that upon Iron Creek can be readily brought down to the main canyon; that at the head of Little Spearfish is at present inaccessible.

District No. 66.

Rock ....Limestone.
Soil ....On ridges and slopes, thin and stony; on ravine bottoms, rich, dark loam.
Humus and litter ..Good.
Forest ....Chiefly a forest of high poles about 110 years old, mixed in some protected ravines with old timber. Trees 12 to 18 inches in diameter and tall and clear boled. At south end forest is interrupted by open parks. Spruce, 12 to 18 inches in diameter, abundant in canyons.
Density ....0.7 to 0.8.
Reproduction.......Excellent.
Cutting ....Slightly encroached upon near Spearfish crossing for mine timbers.
Fire ....Recent fires have not done much damage.
Yield..................15 to 20 cords per acre.

District No. 67.

Rock ....Limestone.
Soil ....As in preceding.
Humus and litter ..Good.
Forest ....Chiefly a second growth about 100 years old, 10 to 14 inches on an average and 50 to 60 feet high, mixed with patches of veterans in ravines and canyons and interrupted by numerous open parks, and on Jackass Gulch there is a large tract burned off and covered with young saplings. Spruce 1 to 2 feet in diameter, aspen, birch, willow, and shrubs in Spearfish Canyon. Near McQuaig's ranch is a belt of excellent old timber.
Density ....0.7.
Reproduction.......Excellent.

CUTTING..............Cut over for lumber near Spearfish crossing and being culled of mine timbers in same district. One sawmill operating at foot of Anna Creek.
YIELD..................In old timber, 2,000 to 3,000 feet of saw lumber per acre; near McQuaig's, 4,000 feet per acre. Of other material, 15 to 20 cords per acre.
FIRE.....................Large tract stripped of timber on Jackass Gulch. Main tract fairly free from injury.

DISTRICT No. 68.—ELK MOUNTAIN.

ROCK....................Limestone and igneous.
SOIL.....................As in preceding.
HUMUS and LITTER..Poor.
FOREST................All burned off except in the main canyon below Maurice, on Squaw Creek, and on False Bottom Creek. At southern extremity of the district, area covered with straggling small pines, aspens, and brush.
CUTTING..............Severely cut north of Carbonate for timbers and cord wood.
YIELD..................3,000 to 4,000 feet per acre in old timber.
FIRE.....................Area has been repeatedly burned and everything killed, except in protected canyons.

DISTRICT No. 69.—LITTLE SPEARFISH.

ROCK....................Limestone, igneous.
SOIL.....................Thin and stony, except in ravine bottoms.
HUMUS and LITTER..Thick.
FOREST................Excellent body of timber at the head of Little Spearfish and Iron creeks and west of the main canyon, averaging 20 inches in diameter, 70 to 80 feet high, and with a clear length of 30 to 40 feet, mixed with second growth of various ages. Lower part of Little Spearfish and Iron creeks very severely burned. In main canyon, oak, spruce, elm, box elder, ironwood, aspen, cottonwood, and many varieties of shrubs are found.
DENSITY..............0.6.
REPRODUCTION.......Exceptionally good.
FIRE.....................Old trees show traces of old fires, and large tracts of second growth have been destroyed by recent fires.
CUTTING..............Lumber removed along Bear Gulch road and near Crow Peak.
YIELD..................Average, 4,000 feet per acre; at head of Little Spearfish, 5,000 feet per acre; 15 to 20 cords per acre.

COLD SPRINGS CREEK.

The larger part of the Wyoming section of the Black Hills is tributary to one stream or, better, canyon, as there is no running water through the greater portion of it. Cold Springs Creek rises in the high Limestone Divide, a few miles west of Crook Tower, within the Dakota line. Its general course is at first west, then it takes a sharp turn northward, running a little west of north. The creek sinks about 15 miles below its head, and from this point to where Sand Creek enters the canyon there is no running water. Below the Black Buttes

A DENSE SECOND-GROWTH FOREST IN WYOMING, WHERE THE GROWTH IS EXCEPTIONALLY GOOD.

the canyon, called in this portion the Grand Canyon, swings to the east of north, and finally northeast, so that the whole course forms an almost perfect crescent.

The bottom of the canyon is open and forms a broad park through its entire length, averaging about 500 feet in width, but at some places widening to 1,000 feet and more. The upper portion is bordered by steep slopes or, in places, vertical walls 100 to 200 feet high, and below the Black Buttes becomes much deeper, till, near Sand Creek, the almost perpendicular cliffs rise 600 to 800 feet above the canyon. On the east side the country is broken into innumerable broad, flat ridges and plateaus, formed by the tributaries of the main canyon. These ridges are separated by ravines and valleys which run in a northwesterly direction, and, like the main canyon, are open and covered with long grass. East of Cold Springs Canyon there is a broad triangular plateau, formed by this creek and Soldier Creek and terminated by the Black Buttes. The Black Buttes consist of a cluster of high ridges and conical peaks, composed of igneous rock, rising abruptly over the plains and covered with a fairly dense forest of pine. West of Grand Canyon there is a broad plateau which is entirely devoid of tree vegetation except where broken by the Red Canyon.

The most important tributary is Sand Creek. This stream rises among rugged, igneous peaks, and has cut out a deep, narrow canyon with precipitous cliffs on each side. It has a northwesterly course till it meets the Grand Canyon, where the latter swings to the northeast.

The high, flat plateaus are composed chiefly of Carboniferous limestone, through which the stream has cut into the Dakota sandstone. The high conical peaks at the head of Sand Creek and the Black Buttes are composed of igneous rock.

The soil on the bottom land is a rich sandy loam. It is excellent over the entire area, except on steep slopes, high ridges, and peaks, where fires have destroyed the vegetable cover. For convenience in describing the forest, Soldier and Stockade Beaver creeks are included in this region. These creeks rise very near together and within a short distance of Cold Springs Creek. Soldier Creek runs nearly parallel to Cold Springs until it approaches the Black Buttes, where it turns to the east. It is dry the greater part of the year.

Stockade Beaver Creek is one of the few continuous streams of the Black Hills. It heads in the Limestone Divide near Crook Tower, and, flowing south, forms the north branch of the main Beaver Creek. After emerging from the timber it enters a broad, open valley, which has to a large extent been taken up by ranchers.

The forest.—The outlines of the timber are very distinctly drawn in this section. The forest terminates abruptly at the foot of the Black Buttes, and the Grand Canyon forms a sharp boundary line on the northwestern side. South of the Black Buttes Soldier Creek forms a sharp terminating line to the timber, and still farther south the forest ends abruptly at the foot of the high Beaver Brakes on the eastern side of the Stockade Beaver Valley.

The forest in this region, especially on the high, flat plateaus, has been a prey to very destructive fires. This portion of the Black Hills has been a resort for hunters, and, being practically unsettled till very recently, both hunters and prospectors have been utterly reckless about setting forest fires. Vast tracts of land have been completely stripped of forest, and everywhere on the ridges there are patches of land burned over and everything killed. Pl. XXXV shows such a fire slash. The greatest burnt areas lie near the head of Cold Springs, at the head of Beaver Creek, between Soldier and Cold Springs creeks near Bald Mountain, and west of Sand Creek, the last being the largest tract of all and covering practically the whole area from the high peaks near the head of this creek to the ridge south of Spotted Tail Gulch. Burnt areas are extensive also on Shepherd and Bear gulches. Most of these fires have occurred recently and there is practically no young forest as yet on the burnt tracts. In some places the young growth which had sprung up after some previous fire has been stripped off by fires running over the same ground. Some of the ridges south of Welcome have clothed themselves with a second growth, and the valleys and gulches have come up to dense thickets of aspen. Many ridges and plateaus are covered with a growth of dwarfed oaks, which grow in such dense masses as to prevent reforestation of pine. Approximately 53 square miles have been burned over so severely that the forest has been entirely destroyed.

At the head of Cold Springs Creek there is a large amount of second-growth timber about 100 years old, mixed at the highest elevations with spruce. Below the bend in the stream the larger timber is encountered, broken at first by fire, but soon becoming denser in the less fire-scarred districts.

The old forest, which is found on the slopes of the canyons and on the rich flats above the ravines, is in some respects the finest in the Black Hills. This timber, where growing in rich soil, is 80 to 100 feet high, 20 to 22 inches in diameter on an average, with many trees 30 inches and even 3 feet through, and with a clear length of 30 to 50 feet. It has grown dense, and has in places a yield of 20,000 to 30,000 board feet per acre. Such a forest is found west of Cold Springs Canyon. A number of acre measurements were taken on Rifle Pit Gulch and near Cold Springs Canyon, which give us a definite picture of the condition of the forest in this section. These measurements are given in the table on page 160. In places this magnificent forest is broken by patches of second growth, which has an apparent age of about 100 years. The reproduction is very fine. In Pl. XXXIV it may be seen how dense the second growth of pine is when the conditions for reproduction are favorable. The forest on the Dakota divide is broken by innumerable patches of dead timber, which has probably been killed by insects.

A LIMESTONE PLATEAU ABOVE RIFLE PIT GULCH, IN WYOMING, WHICH HAS BEEN SEVERELY BURNED.

Such a forest as has been described stretches from Rifle Pit Gulch to Rattle Snake Canyon. It is broken in spots, especially on ridges, by burnt areas, and in the valleys and ravines by the parks. It has an average yield of about 5,000 feet per acre.

Between Cold Springs and Soldier creeks the forest is broken by large blanks caused by fire, and the old trees show the effect of severe burning. There are patches of young growth of every age class from young seedlings to poles about 100 years old. The old timber, which is 20 inches in diameter and 80 feet high, contains a large portion of dying and dead trees, the direct result of fire. In the better portions of the timber there are 20 to 30 merchantable trees per acre. It is estimated that there is a yield of 4,000 feet per acre in this forest. The density is about 0.6. The forest on the Black Buttes consists of old veterans, somewhat stunted and injured by fire, with a large amount of small timber about 12 to 14 inches in diameter. The forest is in places very open and the ground covered with a thick sod of grass. Southeast of the Black Buttes there are large patches of young timber about 40 to 50 years old.

The northern portion of the forest is much broken by burnt areas, but within the canyons there is still an enormous body of excellent timber. This timber begins about the mouth of Spotted Tail Gulch and extends over Sand Creek to and including Dug Out Gulch. The greater portion of this timber is of excellent quality, tall and clear, and most of it sound. In the deep side ravines trees 3 feet in diameter are common and are apparently sound, unlike most of the largest trees on the eastern side of the hills. This forest is broken in places by patches of poles about 10 to 12 inches in diameter, especially on the high, flat ridges. It is estimated that there are about 5,000 board feet per acre over the greater portion.

On Shepherd, Beaver, and Bear gulches the merchantable timber is estimated to yield 4,000 board feet per acre.

The timber near the foot of the canyons is more scattered than above, and, while in places of excellent quality, is scrubby and stunted for the most part. On Stockade Beaver Creek the forest is confined to the head on the eastern side of the stream. On the brakes the timber is straggling and scattered. In the canyons and side ravines entering from the eastern side there is some excellent timber. At the extreme head of the creek the region has suffered severely from fire.

The following half-acre measurements were taken within the Cold Springs district:

Sample plots studied in Cold Springs Creek region.

No.	Merchantable trees.		Other trees.		Board feet.	Cord wood.	Tops.	Dead trees.		Area.	Locality.	Density.
	Numer.	Average diameter.	Number.	Average diameter.				Number.	Cords.			
		Ins.		*Ins.*		*Cords.*	*Cords.*			*Acres.*		
24	14	18	38	12	3,100	7.5	3.5	4	0.7	½	Rifle Pit	0.6
25	31	18	15	13	6,700	3.5	10.0	2	0.2	½	do	0.8
26	29	18	14	12	6,400	3.0	9.5	5	2.4	½	do	0.8
27	20	23	1	18	8,000	.5	12.0	0	0.0	½	Sand Creek	0.7
28	18	21	2	17	5,000	.9	7.5	0	0.0	½	Cold Springs	0.6
29	16	20	9	15	4,000	3.0	6.0	1	1.0	½	do	0.5
30	16	20	9	6	4,000	3.5	6.0	0	0.0	½	do	0.5
31	11	22	5	17	3,700	2.5	5.5	0	0.0	½	do	0.4
32	9	19	2	18	2,000	1.0	3.0	11	7.5	½	do	0.3

Within the deep ravines, especially where there have been fires, aspen comes up in great quantities, and on the burnt tract west of Sand Creek the second growth is largely made up of this species. Along the edges of parks there is always to be found an abundance of aspen, growing as a rule in clusters. It attains a diameter of a foot or more in many places, and one specimen was found 2 feet in diameter. Dwarfed oak and *Ceanothus velutinus* spring up in large quantities in burnt ridges and tend to prevent reforestation.

Characteristic of the forest on the western side of the hills is the large quantity of rank grass, which grows in dense as well as in open woods. Pl. XXXVI shows the thick tangle of weeds and grass found in the Wyoming forests.

Fire.—A general description has already been given of the areas burned over during recent times, and mention has been made of the injury to the forest by old fires. It is believed that the present line of prairie is for the most part an artificial one, if we may judge from the character of timber and the behavior of young growth at the edge of the prairies. The condition of the country about the Black Buttes has, it is believed, been brought about by forest fires, and reforestation prevented by the condition of the soil. The country between Soldier and Cold Springs creeks is said to have been burned in 1895. A most destructive fire occurred in 1894, which started near Crow Peak and, sweeping across Sand Creek, burned to the Grand Canyon on one side and to Little Spearfish on the other. An area of about 200 square miles was burned over. There is said also to have been a bad fire in 1892 east of Calveret's sawmill.

TYPICAL YELLOW-PINE FOREST.

Cutting.—Only a small portion of this region has been touched by the ax. Near Welcome lumber was cut to build the town, but the amount cut was not large. There was formerly a sawmill at the foot of the canyon, and at present a mill, owned by Branderbury, is cutting for the surrounding ranchers and for Sundance (situated in the main canyon near the Black Buttes). There has also been some cutting in Big Springs Canyon, at the foot of the Black Buttes. Peregrew's sawmill, near Soldier Creek, and Sweet's mill, on Stockade Beaver, supply the local demands for lumber. The area cut over is estimated at 4,000 acres.

Industries.—Till lately the region within the timber limits has not been settled at all. Mention has already been made of the large number of prosperous ranchers on Stockade Beaver Creek. There are a large number of ranchers on the divide skirting the Grand Canyon and at the foot of the Black Buttes, and fully a dozen in the canyon. Cold Springs Canyon, Lost Canyon, Rifle Pit, and other valleys have been taken up during 1896 and 1897. On the divides wheat is raised in large quantities, as well as oats and vegetables. Within the canyons timothy and native hay and hardy vegetables will form the chief products, and some attempt will be made to pasture stock within the forest area. Near Welcome there is some mining. The mill at this place is not being operated, but there are a large number of miners busy prospecting and developing discoveries in the vicinity.

DISTRICT NO. 70.—BEAR GULCH.

ROCK ....Limestone and igneous.
SOIL ....On bottom lands, rich and productive; on slopes, thin and stony.
HUMUS and LITTER ...Good.
FOREST ....Veteran stand of pine, 20 to 22 inches in diameter, 70 to 80 feet high, mixed with second growth of various ages and interrupted by numerous large blanks caused by fire.
DENSITY ....0.6 to 0.7.
REPRODUCTION.......Excellent.
YIELD..................4,000 feet per acre, and on a small portion 5,000 feet per acre.
FIRE...................Great damage by recent as well as by ancient fires.

DISTRICT NO. 71.—SAND CREEK.

ROCK ....Igneous, limestone, and sandstone.
SOIL ....Stony.
HUMUS and LITTER ...Light.
FOREST ....Greater portion burned off and now covered with aspen and brush. Northern section covered with fine old veteran forest. Trees 20 to 24 inches in diameter and 80 to 100 feet high, with 2 to 3 logs each.

DISTRICT NO. 72.—RATTLESNAKE CANYON.

ROCK ....Limestone and sandstone.
SOIL ....On bottom lands, rich and fertile.
HUMUS and LITTER...Good.

FOREST ....Original forest of veterans 20 to 22 inches in diameter, 80 to 100 feet high, with clear logs of 30 to 50 feet, mixed with patches of second growth of various ages. Forest interrupted by large burnt tracts and by parks.
DENSITY ....0.6.
REPRODUCTION ......Good.
CUTTING ....Small amount cut in northwest corner.
YIELD ....In part 4,000 feet, in part 5,000 feet per acre.

DISTRICT NO. 73.—RIFLE PIT GULCH.

ROCK ....Chiefly limestone.
SOIL ....As in preceding.
HUMUS and LITTER...Heavy.
FOREST ....Veteran tress of 100 feet, with long clear boles, mixed with second-growth poles about 100 years old. Forest interrupted by large blanks, caused by fire, and by open parks. At summit of divide many trees killed by insects.
DENSITY ....0.7.
REPRODUCTION ......Excellent.
YIELD ....5,000 feet per acre.

DISTRICT NO. 74.—STOCKADE BEAVER.

ROCK ....Limestone.
SOIL ....Rich, deep loam.
FOREST ....At head of creek much burnt. What remains is chiefly a pole forest about 100 years old, mixed with spruce. At head of ravines on east side there are a large number of veteran trees, averaging about 18 inches in diameter and about 70 feet high, and in many cases burnt at the butt by fire. On the brakes, forest is straggling.
DENSITY ....0.5.
REPRODUCTION.......Moderate.
YIELD ....In old timber, 1,000 feet per acre.

DISTRICT NO. 75.—SOLDIER CREEK.

ROCK ....Limestone, sandstone, igneous.
SOIL ....For the most part excellent.
HUMUS and LITTER...Good.
FOREST ....An original stand of pine, averaging about 18 inches in diameter, tall and clear boled, mixed with second growth of various ages up to 100 years. Forest broken by large fire slashes and by open parks. Aspen very abundant.
DENSITY ....0.6.
REPRODUCTION.......Excellent.
YIELD ....4,000 feet per acre.

BEAR LODGE RANGE.

The Bear Lodge Mountains, northwest of the Black Hills, are separated from the latter by a broad, open prairie.

The highest point is situated at the extreme southeastern corner of the range, and from this point the mountains slope gradually toward the Belle Fourche. Warren Peaks form a cluster of high ridges and peaks which reach a height of 6,650 feet above sea level. About these peaks head a large number of streams, which have cut canyons through the hard sandstone and formed a series of ridges radiating out from Warren Peaks in every direction. The country north and west of the peaks is characterized by high plateaus, broken by the numerous streams. There are large tracts of open country on the flat plateaus, and on the slopes and narrow ravines, an open, broken forest.

On the northern side of Warren Peaks head Red Water and Rocky Ford creeks, which empty into Sand Creek; Beaver, Lytle, White Tail, Black Tail, and Miller creeks, which are all branches of the Belle Fourche; and, on the south side, Sundance Creek and South Beaver and Houston, branches of Inyankara Creek. Many of these creeks do not have a continuous stream of water, but the water flows mostly in underground channels and rises at different points, only to sink a short distance below. Ranches are scattered along these branches, and there is said to be on all of them some irrigation. The importance of preserving the headwaters of these streams is obvious. The range has been very severely burned at different periods and the forest everywhere shows the traces of fire. Entire ridges are stripped of the forest, and what old timber remains is chiefly in canyons, where it has been protected from fire. Warren Peaks are entirely bare and covered with grass.

The forest consists of old veterans, situated on protected slopes and in the ravines, averaging 18 inches in diameter and about 70 feet high. On the ridges there is a second-growth forest, about 100 and about 50 years old, which is not yet large enough for lumber. In the gulches there is a large amount of oak brush, and on the ridges a great deal of Ceanothus. There are approximately 8,000,000 board feet in the immediate vicinity of Warren Peaks.

INYANKARA CREEK.

A short distance southwest of the Black Buttes, and separated from them by a broad, open valley, rises a high mountain of igneous rock, with precipitous slopes and a large, flat summit, which is surrounded by a ridge of red-bed limestone. The main peak is densely timbered, but the outlying ridges are forested only in spots, and in such places the timber is small and scrubby.

The timber in Inyankara is mostly rather light, averaging about 14 inches in diameter, except near the base of the mountain, where a large part of the best timber has been cut. It has a density of 0.6. On the ridges around the mountain there is scattered timber, but it is mostly very scrubby and fit only for cord wood. Timber of this character follows the slopes on each side of Mason Creek.

Mason and Inyankara creeks head near the mountain, but not within the timbered portion. This mountain is hardly large enough to form a separate reservation.

It is estimated that there are about 2,000,000 board feet of timber and 15,000 cords of wood on and about the mountain.

On the ridges and peaks southeast of the mountain may be seen scattered patches of forest, but there is no large timber till the high ridges near Mount Pisgah are reached. Among these mountains rise Oil, Skull, and Salt creeks, all branches of Beaver. At the heads of these streams there is a fair amount of timber, of much the same character as that on Inyankara. There are three sawmills operating at present in this section, one in Oil, one in Sweetwater, and one in Freshwater.

It is estimated that there are 22.2 square miles in this section covered with timber. Near the head of Beaver Creek there is a long ridge, running from the head of Mule Creek to the present site of Osage, which is covered with a belt of timber about one-third mile wide. The timber is small and short. It has been culled for lumber by two sawmills, and for railroad ties. Mine props are now being taken out for the coal mines at Cambria. Between this Pine Ridge, as it is called, and Inyankara there are small patches of timber and individual trees. Through the forest in this section is scattered red cedar, which reaches a size suitable for fence posts.

BIGHORN FOREST RESERVE.

(Wyoming.)

By F. E. Town.

LIMITS.

This reserve is situated in northern Wyoming, its limit on the north being the northern boundary of the State. The limits of the reserve, as set forth in the following extract from the Executive order of February 22, 1897, are quite irregular:

Beginning at the southeast corner of township forty-eight (48) north, range eighty-four (84) west, sixth (6th) principal meridian, Wyoming; thence northerly along the range line to the northeast corner of said township; thence westerly along the twelfth (12th) standard parallel north, to the southeast corner of township forty-nine (49) north, range eighty-four (84) west; thence northerly along the range line to the northeast corner of section thirteen (13), township fifty (50) north, range eighty-four (84) west; thence westerly along the section line to the northeast corner of section seventeen (17), said township; thence northerly along the section line to the southeast corner of section twenty-nine (29), township fifty-one (51) north, range eighty-four (84) west; thence easterly along the section line to the southeast corner of section twenty-six (26), said township; thence northerly along the section line to the northeast corner of section two (2), township fifty-two (52) north, range eighty-four (84), west; thence westerly along the thirteenth (13th) standard parallel north, to the southeast corner of section thirty-five (35), township fifty-three (53) north, range eighty-four (84) west; thence northerly along the section line to the northeast corner of section fourteen (14), said township; thence westerly along the section line to the northeast corner of section fourteen (14), township fifty-three (53) north, range eighty-five (85) west; thence northerly along the section line to the northeast corner of section two (2), said township; thence westerly along the township line to the northeast corner of section two (2), township fifty-three (53) north, range eighty-six (86) west; thence northerly along the section line to the northeast corner of section two (2), township fifty-four (54) north, range eighty-six (86) west; thence westerly along the township line to the southeast corner of township fifty-five (55) north, range eighty-seven (87) west; thence northerly along range line to the northeast corner of said township; thence westerly along the township line to the northwest corner of said township; thence southerly along the range line to the southwest corner of said township; thence westerly along the township line to the northwest corner of township fifty-four (54) north, range eighty-eight (88) west; thence northerly along the range line between ranges eighty-eight (88) and eighty-nine (89) west, to the northwest corner of township fifty-six (56) north, range eighty-eight (88) west; thence westerly along the fourteenth (14th) standard parallel north, to the southwest corner of township fifty-seven (57) north, range eighty-eight (88) west; thence northerly along the range line between ranges eighty-eight (88) and eighty-nine (89) west, to the point of intersection with the boundary line between the States of Wyoming and Montana; thence westerly along said State boundary line to the point for the unsurveyed range line between ranges ninety-two (92) and ninety-three (93) west; thence southerly along said unsurveyed range line to the fourteenth (14th) standard parallel north; thence easterly along said standard parallel to the northeast corner of township fifty-six (56) north, range ninety-three (93) west; thence southerly along the range line between ranges ninety-two (92) and ninety-three (93) west, to the northwest corner of township fifty-four (54) north, range ninety-two (92) west; thence easterly along the township line to the northeast corner of said township; thence southerly along the range line to the southeast corner of said township; thence easterly along the township line to the northeast corner of township fifty-three (53) north, range ninety-one (91) west; thence southerly along the range line to the southeast corner of said township; thence easterly along the thirteenth (13th) standard parallel north, to the northwest corner of township fifty-two (52) north, range eighty-eight (88) west; thence southerly along the range line between ranges eighty-eight (88) and eighty-nine (89) west, to the southwest corner of township fifty-one (51) north, range eighty-eight (88) west; thence easterly along the township line to the southeast corner of said township; thence southerly along the range line between ranges eighty-seven (87) and eighty-eight (88) west, to the southwest corner of township forty-nine (49) north, range eighty-seven (87) west; thence easterly along the twelfth (12th) standard parallel north, to the northwest corner of township forty-eight (48) north, range eighty-seven (87) west; thence southerly along the range line to the southwest corner of said township; thence easterly along the township line between townships forty-seven (47) and forty-eight (48) north, to the southeast corner of township forty-eight (48) north, range eighty-four (84) west, the place of beginning.

These limits conform, in a general way, to the limits of the Bighorn Range, although not at all closely. In some places they inclose small areas of the plains upon the east and west sides; in other cases considerable mountain areas are excluded. The range extends far to the south of the southern limit of the reserve; indeed, not more than two-thirds of the length of the range is included in the reserve.

GENERAL DESCRIPTION.

The Bighorn Range has the form of a long, narrow ellipse, the axis of which trends nearly north and south in the southern part, but turns toward the northwestward in the northern part. The breadth from base to base ranges between 30 and 50 miles. The length is not easy to estimate, as the range falls off gradually at its north and south ends, but is probably between 75 and 100 miles. On the east are the plains and on the west the Bighorn Basin. Structurally the range consists of a great anticlinal fold, broad, flat, and steep upon the flanks. Upon the east and west sides of this fold the stratified beds lie up against the range, dipping at angles of 25° to 90°. From the summit of the fold the stratified beds have in most places been eroded, exposing the granite nucleus, although toward the north and south ends of the range, portions of the stratified beds are still found, in some places in scattering tables, in others lying continuously across the range. The plains at the east base have an average altitude of 4,000 to 5,000 feet above sea. The rim rock, as the summits of the inclined stratified beds

A CLOUD PEAK AND PART OF THE HIGHER PORTION OF THE BIGHORN RANGE.

B. BIGHORN MOUNTAINS, WYOMING, NEAR LITTLE GOOSE CREEK CANYON, SHOWING WHERE FOREST FIRE HAS STOPPED AT DRAINAGE LINE are called, rises to 7,500 and 8,000 feet upon the east, and upon the west to varying altitudes, in some cases much higher. Within the rim rock the summit of the range is for the most part undulating, presenting comparatively little relief, and with an altitude ranging from 8,000 to 9,000 feet. Here and there, however, over its surface, granite summits rise irregularly to altitudes exceeding 10,000 feet; and from the middle of this plateau east and west, and toward the south, is a range of mountains rising from the plateau 4,000 or 5,000 feet, its altitude above the sea reaching, in the highest summit (Cloud Peak) 13,100 feet.

Cross sections of the range made in different latitudes show differences in the thickness and dip of the rim rock. In the latitude of Buffalo the rim rock on the east has a moderate breadth and stands nearly vertical, while that on the west has a comparatively slight inclination and great breadth. Farther north, in the latitude of Massacre Hill, the beds upon each side are narrow and dip steeply, about 45°. In the latitude of Dayton the rim rock on the east stands vertical or nearly so, Cambrian beds extend across the range, and the rim rock on the west side is broad. Thus the range is asymmetrical, and its asymmetry differs in different latitudes.

The streams heading upon the high range and elsewhere on the plateau flow commonly in shallow valleys on or near the surface of the plateau until they approach the rim rock, whence the descent to the plains is extremely rapid through gorges cut in the granite and lower down in the stratified beds.

As compared with other ranges of the Rocky Mountain system this is in an early stage of development. The stratified beds flanking it, which in most ranges have been eroded away in great part, leaving "hogbacks," here rise almost to the level of the summit of the plateau, while the plateau itself, so far as the granite nucleus is concerned, has as yet suffered but little. The streams do not yet approach a normal profile, but conform in great measure to the slopes upon which they flow. Apparently little of the granite nucleus has been removed by erosion.

In early days this area was filled with game, and was a favorite hunting ground for the Crow and Sioux Indians. It is but a few years since they were driven out and the region became accessible to the white man. Settlement has made very little progress. The land is, in the main, too high and possesses too severe a climate for agricultural operations; consequently there are very few ranches. It is, however, used very extensively as a sheep range during the summer, flocks being driven there long distances from the plains and valleys.

Its surface is drained on the west side by branches of Bighorn River, on the north by Little Bighorn, and on the east by branches of Tongue River. The main or principal divide separating the waters of Tongue River from those of the Bighorn pursues a rather sinuous course. In the northern part of the range it hugs the western edge of the plateau, farther south it follows the divide of the high range capping the plateau, and in the southern part it is in general not far from the mid line of the plateau, although in detail its sinuosities, as shown in the map, are much greater than is here indicated.

CONDITION OF FORESTS.

The general aspect of the reserve is that of a lightly forested region. It contains no large or valuable timber. Nearly all has been burned, much of it recently, and a large part has been subjected to repeated fires. A considerable proportion of its area consists of open parks from which the timber has evidently been completely driven out. Another large part is covered with a young growth, ranging from 10 to 50 years of age, while the ground is strewn with dead trees, the victims of fires, in an intricate cobwork. As a rule, these trees are small. It is only in limited localities that mature forests exist.

The destruction of the forests of this region dates back, in the main, to the time of its occupancy by Indians. The fires were doubtless set by them for the purpose of driving out game or improving the pasturage. Since the occupancy of this region by white men there have been few fires and these have been small.

The ridges (divides) next to the central divide on both the east and west bear the heaviest and best growth of timber found in the reserve and are generally well covered for most of their length. The rim rocks are less heavily timbered. The eastern rim rock is bold and precipitous and barren of timber, except that in some places patches of pine are found, usually high up the sides or toward the top. On this ridge the sides sloping inward, the western slopes, are generally fairly well timbered.

On the extreme western ridge the outer (western) slopes are more gradual in their descent to the basin than are the outer slopes of the eastern ridge, and are almost entirely destitute of timber. These slopes show a good deal of sand rock, and most of the roads and trails on them are deep with sand, apparently deposited there from the Bighorn Basin. The inner (eastern) slope of this ridge, toward the central divide, is for the most part fairly well timbered.

Following the mountain range, going north, at about the canyon of Shell Creek, the outer (western) ridge disappears, and a little farther north the next also disappears, and Bald Mountain, standing in the main divide, becomes the outermost ridge or rim rock.

Also following the range north on the eastern side, the two ridges which farther south were distinct blend into one north of Black Mountain and Tongue River, and thence northward there are but two distinct ridges, the western, of which Bald Mountain is part, and the eastern ridge. Among the spurs of these two ridges the tributaries of the Little Horn rise, and between them that river flows.

PARKS.

In every part of the reserve are found areas destitute of timber, which are called parks. These vary in extent from a few acres to thousands of acres. It is impossible to estimate with any accuracy their aggregate extent, but it is very great. I think it is quite safe to estimate that not less than one-half of the area of this timber reserve consists of such parks.

These parks are covered with grass and in most cases contain no trace of timber, but in some have been found the remains of large stumps, charred and evidently burned very long ago. I am of opinion that these parks were at one time covered with timber, which successive fires have long ago destroyed down to the roots, and afterwards the places occupied have grown up with grass. There appears no reason why timber should not grow on these places if seeded there, and, indeed, it may be noted that the timber is now gradually encroaching upon many of them; isolated saplings are seen growing at a distance from the body of timber surrounding the park, say from 25 to 100 feet away from the nearest timber. These trees could not have sprung up alone in the park unless a seed blown or carried there had taken root. From this I infer that if fire were kept out, in time all these parks would grow up with a good stand of timber.

There appears no reason why these parks should have been always barren of timber, nor why they should remain so now. They have the same altitude, climate, and other conditions as the timber-bearing areas surrounding them; the soil is richer and deeper than in the timber areas, doubtless due to the formation of soil by the decay of successive crops of grass. As the remains of old stumps found in some certainly indicate that timber once grew in them, and as young timber grows now when seed reaches them, I see no reason to doubt that with proper treatment they can all be made to bear a heavy growth of timber.

SPECIES OF TIMBER.

Almost all the timber of the reserve is pine, and is confined mainly to one species, *Pinus murrayana*. This is known locally under various names, lodgepole pine, white pine, yellow pine, jack pine, and piñon, these different names being applied apparently on account of the difference in size, age, and peculiarities of growth. It is found generally distributed over the reserve at all altitudes, from the level of the plains to timber line. It possesses a very coarse grain, never grows large, and is very knotty. It is more resinous than the white pine of Michigan and Wisconsin, but not so much so as the yellow pines of the South. The lumber manufactured from it warps and cracks badly. Examination at the sawmill rarely develops a piece which would be accepted on inspection in any lumber market as No. 1, or even as merchantable, because of its slits, cracks, and knots, and its tendency to warp and twist; still, for domestic uses by the settlers in the vicinity it answers a very good purpose, and as the only lumber available it is invaluable to them.

Another species of pine, *Pinus flexilis*, is found scattered sparsely among the *P. murrayana.*

There is, in certain localities, a considerable growth of spruce, *Picea engelmanni.* This is usually found in the bottoms near the streams, but in some places it grows high up on the mountain sides, where springs appear to supply moisture. This is used with the pine, just as it comes to hand, with very little discrimination, although pine is preferred when it can be obtained as readily. Spruce is used for the same purposes as pine.

A small fir, *Pseudotsuga taxifolia,* is found, but it is so rare that mention only is necessary. Balsam fir is found in small quantities, growing with pine and spruce. It is, however, not used when any other wood may be obtained, as it rots quickly.

In one locality, on a dry canyon of Paint Rock Creek, a growth of some 250 or 300 acres of juniper was found. It is small, scrubby, and of no commercial value, but its appearance on a tract by itself, where nothing else was growing, seemed quite remarkable. I have found at high altitudes what these people call cedar, but only as a bush, scarcely more than a vine. This growth was from 4 to 10 inches in diameter and 10 to 18 feet in height, with no other timber of any kind on the same area, but all was more or less rotten.

The banks of the stream at lower altitudes are lined with willow, aspen, and cottonwood. The willow grows only to the size of a bush, and the aspen and cottonwood are usually only shrubs. Some grow to the height of 20 to 25 feet, but neither has any commercial value. I have seen some cottonwood trees 16 to 20 inches in diameter, but the trunks were short, scrubby, and unsound.

FOREST FIRES.

There are extensive areas in the reserve which have been devastated by fires of more or less recent date; in some places for miles, as on the West Fork of Big Goose Creek and on Wolf Creek and parts of Shell Creek, the mountain sides are strewn with the débris of these fires. In these places the timber lies heaped and tangled on the ground, crossed and recrossed, often to the height of a man's head. The timber is generally small in size, from 3 to 8 inches in diameter, and a great deal of it is rotten. Among it are seen some trunks of trees from 16 to 20 inches in diameter, and occasionally one even larger.

A great many of the fires which caused this wreck appear to have occurred about twenty-five years ago. This is indicated by the small saplings which are found growing in greater or less profusion out of this débris. These areas are found more in the southern than in the

A. VIEW IN BIGHORN MOUNTAINS, WYOMING NORTHWEST OF DAYTON, SHOWING CONDITION OF FOREST ON EAST SLOPE.

B. VIEW IN BIGHORN MOUNTAINS, WYOMING, HYATTSVILLE ROAD, EAST FORK OF BIG GOOSE CREEK SHOWING FALLEN TIMBER TEN TO FIFTEEN YEARS AFTER FIRE RAN THROUGH IT, WITH NEW FOREST GROWTH SLOWLY STARTING UP.

northern parts of the reserve. I conclude that the largest part of the reserve south of Tongue River was burned over during the Indian hostilities of twenty-five to thirty years ago.

There are also considerable areas of dead timber still standing which was killed by fire. When the timber has been fire killed, there is not much of it burned so as to fall at the time; it will stand until the roots and lower parts become rotten, and then it is blown down by the violent winds which are prevalent in these mountains at certain seasons. Large numbers of these dead trees are seen blown down during the windstorms which have visited these places. Quantities of dead timber, both standing and fallen, are also found among the green living and growing trees, and in many instances there is as much dead as living timber. This dead timber has been fire killed, and some of it has remained standing until the new growth has sprung up and attained its present size. In some of the largest and best growths of timber there is a considerable mixture of this dead timber.

SIZE OF TIMBER.

There is but little timber in this reserve large enough for commercial purposes. There are large areas of saplings from 2 to 4 inches in diamter and 10 to 16 feet in height, 20 to 25 years old. These constitute the growth after more recent fires. A much larger percentage is from 5 to 10 inches in diameter and 25 to 60 feet in height. This is a growth which has come up after fires of older date. These trees are from 50 to 60 years old, but are still too small for any manufacturing purpose.

There are some patches of poles, 3 to 6 inches in diameter and 30 to 50 feet high, which are used by farmers for fencing and making corrals; and in some localities there are found, mixed with a thick stand of smaller timber, a few trees large enough to furnish logs for sawing and for making railway ties, say 11 to 15 inches in diameter and 60 to 80 feet in height; but it must be noted that the logs sawed here are smaller than would be used by any mill in the Eastern States or in lumbering districts elsewhere; besides, the quality is so inferior and the logs are so knotty that lumber from them would not be used if anything better could be obtained.

This timber, when of sufficient size, both pine and spruce, is very well adapted for railway ties, because knots are no objection; to some extent it has been so utilized.

The usual method of constructing farm buildings is to use logs hewn square or flat, about 6 inches thick, and notched together at the corners. This timber, 8 to 10 inches in diameter, is well suited for this purpose, and settlers near the mountains have used a good many logs for this purpose, as well as smaller poles for fencing and corrals. The valley settlements on both sides of the mountains depend largely for fuel on the wood hauled from the mountains, and for this purpose they prefer dead timber, not only because it is dry and better to burn, but, being lighter, they can haul more at a load.

CLASSIFICATION OF TIMBER.

The northern portion of the reserve seems to have suffered less from fires, or certainly from fires of recent date, than the southern portion, and therefore contains the largest and best timber. In this report I shall class as "merchantable" all areas which contain a fair percentage of trees large enough for commercial uses at the present time; the areas in which the timber is at present too small for such uses I shall class as "young timber."

There is a large body of timber, which may be rated as the best in the reserve, lying between the South Fork of Tongue River and Wolf Creek, and extending from the valley of Sheep Creek on the north to near the head of the West Fork of Big Goose Creek on the south. This body averages about 6 miles in width by 15 miles in length, and contains about 60,000 acres. A portion of this area, including Black Mountain and Sheep Creek Valley, has been cut over for railway ties, but only about one-third of the area which has been so cut over is within the limits of the reserve.

There is another area of about half that extent, say 30,000 acres, on the Little Horn, partly on the Dry Fork of Little Horn and partly on the main stream and its other tributaries. The part on the Dry Fork has been partially cut over for ties, and that on the main canyon suffered considerably from fire in the summer of 1898.

The other areas of timber containing trees large enough for sawing or tie making in sufficient quantity to be classed with the merchantable areas are small bodies standing where they seem to have escaped from fires long enough to attain to a useful size. Along the valley of Tongue River from the junction of the South Fork nearly up to Little Bald Mountain, on the south side of the Tongue, there is a body of such timber about half a mile wide and about 10 miles long, say 3,200 acres. South of Dome Lake, on the West Fork of Big Goose Creek, is a small body about half a mile wide and about 1 mile long, say 320 acres in area. On Willetts Creek there is a body of timber about 5 miles long and from one-half to 1 mile wide, say 2,400 acres in area. This timber has been fire killed, but is standing, is sound, and contains enough trees of useful size to class it with the merchantable areas. On Trappers Creek is a body of timber about half a mile wide by about 2 miles long, say 640 acres in area. On Black Butte, a mountain north of and near the head of Medicine Lodge Creek, there are about 2,000 acres of timber. At the head of Paint Rock Creek is a body about half a mile wide by about 1½ miles long, say 480 acres in area. At the head of Broken Back Creek is a body about half a mile wide by about 3 miles long, say 960 acres in area. About Ten Sleep Lake and Paint Rock Lake are several bodies, which I estimate at about 6,000 acres.

AMOUNT OF MERCHANTABLE TIMBER.

The areas enumerated aggregate about 106,000 acres, which contain enough timber of present useful size to be classed as merchantable, of which about 22,000 acres have been cut over for ties, leaving, say, 84,000 acres not cut over.

A larger quantity of lumber, computed in board measure, can be obtained from such timber as this is when it is cut into ties than in any other form of manufacture, and I have found by counting the stumps in abandoned tie camps that the cut averaged about 75 ties per acre; the ties contain 32 feet B. M. each, which would make the average 2,400 feet B. M. This estimate has since been verified by the tie contractors. I therefore estimate the yield of the best timber at 2,500 feet B. M. per acre.

This would make the standing timber of merchantable size on the 84,000 acres of the reserve not yet cut over about 210,000,000 feet B. M.

Some of this is not now accessible, and some of it stands in such small bodies that no one could afford to cut roads to bring it out at the present time.

This estimate does not, of course, include the whole quantity of timber actually standing within the limits of the reserve, but only the small percentage which is at the present moment of suitable size for manufacturing into salable material, lumber or railway ties, and is therefore classed as merchantable.

CONDITION OF YOUNG TIMBER.

Upon the same tracts which are enumerated above there is a much greater quantity of timber that is yet too small for any commercial use. In those tracts where the ties have been cut there is no apparent difference in the forest to the eye of one not accustomed to timber operations; the growth appears as dense as before. There is now standing on these tracts a much larger number of small trees than can ever come to maturity. If the forest is not thinned out by cutting, the more vigorous of the growing trees will crowd out the weaker ones and a great many will of necessity die, while a heavy forest growth will still remain. This is also true of several hundred thousand acres which I class as young timber because it contains none of sufficient size for present use, except such as may be taken by farmers for fencing, etc., and this quantity is so small that it makes no perceptible diminution in the growth.

It is impossible to estimate the quantity of lumber which may be obtained from this forest in future years if it could be preserved. There is probably not less than 500,000 acres of young timber which in time, perhaps in thirty to fifty years, would be of useful size, and if cut under proper regulations would make available at least 1,000 to 1,200 million feet of lumber then, and thereafter a large annual crop could continually be taken from the constantly maturing trees, without diminishing the forest, but rather to its benefit. In addition, if fires can be prevented, the parks will gradually become covered with timber and more than double the available quantity. By this means the forest could be made to supply the needs of a large neighboring population for all time to come.

The character in detail of the standing timber not above specified as merchantable is as follows:

Little Horn River has been visited by a severe fire this summer. The timber on this stream and on its tributaries which has not been burned is classed as merchantable. It consists of both pine and spruce, mostly pine.

On Pass Creek the timber is mostly small, 6 inches to 10 inches diameter and 30 to 50 feet high, but it contains some few trees large enough for manufacturing, although there is not enough to grade the timber with the merchantable class. This statement applies to both forks of the creek, which head in the Little Horn divide, and both forks have timber in patches until the canyon sides become steep rock walls and the timber ceases. The trees are nearly all spruce, but some little patches are pine.

Columbus Creek, the next south of Pass Creek, is short and its canyons are deep. The timber is in small patches on the sides of the canyons and is mostly spruce, but there is some pine with it. It is too small to class as merchantable.

The timber on Tongue River and its tributaries is included in the merchantable timber; and the timber on Little Tongue River, which heads near Black Mountain, is also included in the merchantable.

The timber on the west side of Wolf Creek is also included in the merchantable area. On the east side all the timber is burned up to the West Fork of Big Goose Creek.

Soldier Creek heads in the foothills and bears no timber.

On Big Goose Creek the timber of the West Fork is all burned as far as Dome Lake. Above that there is some merchantable timber, as stated. Almost the entire length of the East Fork contains a good stand of small pine timber.

All the forks of Piney Creek are similar in character of timber, and all contain a good stand of small timber, mixed with a few larger trees, but not enough to grade the area as merchantable. The timber is mostly pine, but there is some spruce low down in the canyons. Rock and Sayles creeks are similar in character to Piney Creek.

About the heads of the forks of Clear Creek are some stands of small, green pine, mixed with dead trees of small size, both standing and fallen.

About the heads of Powder River, Poison Creek, Muddy Creek, and Crazy Woman Creek tracts of dead, small timber are on the ground, alternating with large tracts of small saplings, 6 to 12 feet high and 2 to 3 inches in diameter. This growth is all pine, and stands so thick that it would be difficult for a man on foot to get through. Besides the merchantable areas above enumerated, Ten Sleep, Broken Back, and Paint Rock creeks have patches of small pine, but no considerable bodies, and all are similar in size and quality. Among these patches there are some few trees large enough for present use, but not enough to put them in the merchantable class.

The southern portion of the reserve contains extensive parks, much greater in the aggregate area than all the timber areas of all kinds in the same limits. This is in line with my theory that these parks are merely burned-out stands of timber, for there is evidence that there have been more fires—certainly more in recent years—in the southern than in the northern portion of the reserve.

Trappers Creek, besides the merchantable areas named above, contains small pine, with a few trees of present useful size, but not enough to grade as merchantable.

Near the heads of Shell Creek is a thick stand of small, green pine timber, containing some few trees of useful size. On the divide between this creek and Willetts Creek is a large area of burned timber, both standing and down, and growing up among it is a very thick stand of small saplings, 2 to 4 inches in diameter and 12 to 18 feet high. The lower part of Shell Creek Canyon was burned over in the summer of 1898; it contained some merchantable pine timber.

Porcupine Creek has some areas of spruce in the bottoms, and also has scattering areas on the sides of canyons; none of these are of any considerable extent, and on the hillsides the growth is mixed pine and spruce. All of the timber is small and young.

From the rim rock to the heads of Beaver and Bear creeks there was a good stand of merchantable timber, but all has been burned this summer.

On Lime Mountain, southeast of Medicine Mountain, are some small patches of young pine timber.

Tepee Creek has a thick stand of small pine timber on both sides throughout its whole length.

The growth of timber in these mountains is very slow. The climate is arid; there is little rainfall during the season of growth. The season is short; snow usually lies on the ground from November to June. The temperature is low; there is no month in which frosts do not occur in the mountains; and the forest fires which have occurred year after year have burned up the mold on large areas, so that the growing timber has to struggle against every disadvantage.

SOIL AND HUMUS.

In the districts where fire has killed all the timber, and it lies piled up on the ground, as on Big Goose Creek and Wolf Creek, I found practically no soil, merely gravel and rock, with so little soil on top that it could not be measured. In districts where the young timber is standing, 50 to 60 years old, I found 2 to 3 inches of mold; and in the parks, where no timber stands and grass is growing, I found 6 to 8 inches of mold. And there are some few places, notably near Dome Lake, where the bottoms or parks are a bed of peat from 1 to 3 feet deep, but these are not anywhere of great extent.

AGE OF TIMBER.

At altitudes of about 9,500 to 10,000 feet I found that the saplings, 3 to 4 inches in diameter and 12 to 16 feet high, were 22 to 25 years old. These were growing up amidst the débris of fires, where the timber is all down on the ground. At 9,500 feet altitude, on Big Goose Creek, in such a burned district, I found a growing pine 16 feet high and 3½ inches in diameter to be 45 years old. At 9,000 feet altitude, in one of the most desolate burned districts, I found a pine 20 feet high and 6 inches in diameter to be 40 years old. This and the one before described as 45 years old were growing in very similar places. Near Bald Mountain, at about 9,000 feet altitude, I found a green spruce 16 inches in diameter to be 180 years old, and one 12 inches in diameter to be 120 years old. On Tongue River, at about 7,000 feet altitude, I found green pines as follows: One 12 inches in diameter, 108 years old; one 16 inches in diameter, 110 years old; one 20 inches in diameter, 120 years old. In the valley of Piney Creek, clear of the mountains and on good soil, I found the stumps of pines which counted as follows: One 16 inches in diameter, 60 years old; one 18 inches in diameter, 70 years old; one 24 inches in diameter, 110 years old; one 27 inches in diameter, 150 years old; one 40 inches in diameter, 160 years old. These trees in the bottom grew very rapidly, and the grain was very coarse, some of the rings being one-fourth of an inch thick.

This timber has a very short taproot, and in some cases almost none. The roots spread out over the rocks, and the tree has comparatively a very slight hold on the ground to maintain its position against the force of the winds or the weight of snow. I think a part of the timber lying on the ground may have been blown down or borne down by snow from want of root.

There is no undergrowth in the pine and spruce tracts except young trees of the same kinds, and no litter except the fallen leaves and cones and the timber lying on the ground.

The older trees, large enough for use, have very short trunks, say about 16 to 20 feet, and have branches above in great profusion. The stock below the branches is full of knots. But among the young timber, and especially in the smaller sapling stands, the growth is much better and would develop into good timber if protected. In these tracts the small trees stand very close together, so that in places it is almost impossible to pass between them; the branches are nearer the top, the trunk is freer from knots, and as the tree grows it develops longer and cleaner stocks.

There are many more trees in these stands than could ever grow to maturity, but if the thickets could be thinned out, leaving the best trees and allowing them room to grow, they would develop into good merchantable timber.

It has been almost impossible to find any living cones on either pine or spruce. I searched diligently over many miles of forest and spent weeks of time to find the specimens which I finally obtained.

I have observed that it is hardly possible to find a large tree at any considerable altitude, say 7,000 feet and over, which is sound. When they have attained a size 18 inches to 20 inches in diameter they are almost always found to be rotten at the root and in the center of the lower trunk. Many such are found down, with no evidence of having been burned, but have apparently rotted at the bottom and fallen. Such trees are about 200 years of age, and I am of opinion that they then lose vigor and die of old age. I have been unable to discover any parasite or any evidence of disease which might cause the death of these trees.

The only valuable information I could obtain with regard to the fuel properties of this wood was from Mr. Tewksbury, manager of the Fortunatus Gold Mining Company at Bald Mountain. He has made tests which he claims have been scientific and thorough, and states as his conclusions that of the pine growing at that altitude, about 10,000 feet, it requires 2 cords to make the same amount of steam which can be got from 1 cord of pine grown in the valley, at about 3,500 feet altitude, and that it requires 6 cords of valley pine to make as much steam as 1 ton of soft coal; and therefore, in his opinion, it requires 12 cords of pine grown at 10,000 feet altitude to make the same amount of steam which 1 ton of soft coal will make.

BURNT AREAS.

Fire has been and is the greatest enemy of this forest. There are large areas burned over and destitute of timber. On some of these the trees have been recently killed by fire, but are still standing and are sound timber; on others, burned longer ago, the trees are standing or but few have fallen, and the timber is mostly sound, although it is to some extent mixed with rotten timber; but on by far the larger portion the timber has been burned so long ago that it has been blown down and lies piled several layers deep, a tangle of charred and rotten timber. This is almost all of small size, from 3 inches to 7 or 8 inches in diameter. These places appear to have been burned twenty-five to thirty years ago, as there is a growth of young saplings about 20 to 25 years old springing up through almost all of this débris. Many areas of the standing and growing young timber, as well as many of the areas designated as merchantable, contain a great deal of this burned, dead timber, lying on the ground under the growing forest and in some cases standing among the growing timber.

There is abundant evidence from these appearances that every acre of these mountains has been burned over at some time, and probably many times successively in the past. Some parts, having had a longer respite than others from the recurrence of fires, have had time to develop a larger and better growth.

The effect of these fires is most disastrous and reaches beyond the mere destruction of the timber which they burn and kill. The soil (humus) is more or less burned during these fires, and in so dry a season as the present one has been it is entirely consumed as far as the fire extends. This deprives the seedlings which spring up in succeeding years of the source of nutriment which they require and retards their growth, thus requiring much longer time to repair the ravages of the fire. It is difficult to conceive and impossible to estimate the amount of present and future value destroyed by these forest fires.

During this summer (1898) I have witnessed several large fires in the reserve. I spent two days and nights near one on Piney Creek, noting its progress and assisting in the efforts to conquer it.

The list of this summer's fires in this reserve is as follows:

A fire commenced on the divide between Prairie Dog and North Fork of Piney Creek. It is believed that it was started from the camp fire of a sheep herder. It was spread by high winds and burned over the divide into the canyon of Little Goose Creek to the north, along the divides to the South Fork of Piney to the south, and from 6 to 8 miles westward, covering an area of about 30,000 acres.

A fire commenced in Shell Creek Canyon and burned through that canyon and on the divide about 10 miles long by 1 to 2 miles wide, covering, say, 10,000 acres. The origin of this fire is not known, but is said to have been started by Indians.

A fire commenced on Beaver Creek and burned over all the area between Beaver, Bear, Alkali, and Shell creeks, an area of about 12,000 acres. This is also said to have been started by Indians.

A fire commenced on the canyon of Little Horn River and burned over some of the northern forks or tributaries of the Little Horn and a portion of the main canyon of this stream, then crossed the divide between Little Horn and Lodge Grass, and extended into Montana. This fire burned the timber on at least 10,000 to 12,000 acres of the reserve. It is also charged to the Indians.

The Beaver and Little Horn fires consumed mostly timber of merchantable grade—that is, of the size for present use. The Piney fire was mostly in small young timber; but in this timber there were a few trees of present useful size. The Shell Creek fire was on land which was covered partly with merchantable timber and partly with smaller sizes.

There have also been a number of small fires in almost every part of the reserve, which burned over only small areas. It will be within bounds to estimate the destruction of timber in the reserve by fire, this

A.

B.

VIEWS IN BIGHORN MOUNTAINS, WYOMING, NEAR HYATTSVILLE ROAD, WEST FORK OF BIG GOOSE CREEK, SHOWING REMNANTS OF FOREST LEFT AFTER FIRE.

summer only, at 70,000 acres, a number several times as great as has been taken from these mountains by every other means since the white man struck the first blow of his ax, including lumber and ties made and all other timber that has been taken by settlers. The entire deforestation of these mountains would be a short process if fires should continue at this rate. At the time I finished my field work, October 9, the Piney and the Little Horn fires were still burning, but on the 11th there was a considerable fall of snow in the mountains, which, I presume, extinguished them.

Early in the summer a band of Shoshone Indians visited the Crows and returned through these mountains by trails leading past the place these fires commenced, and it is quite likely that they started them.

TIMBER CUTTING.

The only timber taken from these mountains for manufacturing purposes in quantities sufficient to be worthy of note has been that used in the manufacture of railway ties.

There are at present 6 sawmills in operation on or near the reserve. The mill of Mr. Heald, at the mouth of Big Goose Canyon, is a small water mill cutting about 100,000 feet per year from logs taken from the gulches on that creek. It finds a market for its product in the Sheridan Valley. The mill of Lobban & Hines, on Piney Creek, is just outside the lines of the reserve, but part of the logs it uses are taken from the reserve. It has been in operation for about twelve years. It is a small water mill, at present run under lease by Mr. Warburton. It cuts about 500,000 feet per year, and finds a market for the product in the Sheridan Valley. The common grades of rough lumber are sold for about $14 per thousand feet at the mill.

The mill of Mr. Barr, near the head of Columbus Creek Canyon, is out of the reserve, and so far away that it takes no timber from the reserve. It has been in this location four years. It is a steam mill, cuts about 300,000 feet of lumber per year, and sells the product in the Sheridan Valley, obtaining about $10 per thousand feet for common lumber at the mill.

The mill of Gaylor & Perkins, on Trappers Creek, has been in that location for several years. It is a small steam mill and cuts about 500,000 to 600,000 feet per year from logs taken from gulches on Trappers Creek. The logs are small, and include both spruce and pine. The mill "squares up" a good many sound dead logs, hauled in by farmers to use for "house logs," which the farmers have sawed square instead of hewed square before they are notched together for house building. The mill of Mr. Rhinehart is located on Medicine Lodge Creek; it is a small steam mill, which cuts about 150,000 feet per year, principally pine. The mill of Milo Burke is a small water mill on Broken Back Creek, which cuts about 100,000 feet per year, principally pine. The market for the product of these 3 mills on the western ridges and slopes is in the Bighorn

Basin. About $10 per thousand feet is obtained at the mill for common rough lumber.

There is no means of transporting the lumber from these mills to the places where it is used except by wagons, and it is hauled distances varying from 20 to 40 miles, and even farther in some cases. There is also no way to transport the logs from the stump to the mill except by hauling on wagons or sleds. The logs large enough to saw are so few that it is necessary to pick out trees over a considerable extent of territory to find enough of suitable size. They are usually hauled from distances varying from 1 to 3 miles.

The only attempt made in these mountains to use the streams to bring logs to the mill was by Mr. Warburton, at Piney Creek mill. He tried to float logs down the Piney, but found it impossible to do so. The cost amounted to $8 per thousand feet, and some of the logs were ruined by being driven and beaten against the rocks.

Some logs have been got down by means of a flume, of which I shall speak later.

In addition to these 6 mills there is being erected a water mill on the Big Goose Creek by Mr. Wilkerson, which he estimates will cut about 1,000,000 feet per year. This will not be in operation this year. Messrs. J. H. McShane & Co. have at Rockwood, on Tongue River, a fully equipped and first-class steam sawmill, modern in every way, and capable of cutting 25,000 to 30,000 feet per day. They built it mainly to cut lumber for their own use. They can not run it for want of logs of suitable size. It has cut about 1,000,000 feet in all, most of which they used in constructions of their own mill.

The only other consumption of timber from this reserve (except for railway ties) has been by settlers and residents who have used logs and poles for house building and fencing, etc., and deadwood for fuel. All that has been taken by settlers and mills has had no perceptible effect upon the forest.

In 1893 Mr. Hall contracted with the Burlington and Missouri River Railroad to make and deliver 1,600,000 ties of pine, and he expected to get the timber to make them from the public lands which were most conveniently situated. He commenced cutting on Sheep Creek, and constructed a flume down that creek to Tongue River, his plan being to run them in the flume to Tongue River and drive them down that stream loose in the water to the point where the railroad crosses the stream. This was found on trial to be impracticable. The ties were hung up, some were lost, and many were destroyed by being beaten against the rocks. Mr. Hall failed, and then the railroad company induced Messrs. J. H. McShane & Co., of Omaha, railroad contractors, to take up and finish Mr. Hall's contract for ties. I understand that Mr. Hall got permission to cut ties on some of the public lands, but I am not informed of the details of the arrangement. Under this or a similar permit McShane & Co. cut some ties used in the construction of that road. Afterwards McShane & Co. acquired a title to a good deal of land in townships 55 and 56 N., R. 88 W., from which they cut ties. These two townships appear to have been cut out of the reserve, or at least the reserve lines are run so as to exclude them, so that I presume they were omitted because so much of these townships consisted of private lands.

McShane & Co. have completed the Hall contract and furnished the railroad in all about 1,750,000 ties, including the number Hall furnished before he failed. This represents about 56,000,000 feet in board measure, and, to get this quantity, timber large enough for ties has been cut from about 22,000 acres on Black Mountain, Tongue River, Sheep Creek, and Little Horn. They completed their work last spring, and are not now operating. In doing this work they have made very large investments; they have constructed in all about 17 miles of flume, by means of which ties or lumber can be brought entirely out of Tongue River. This was a piece of skillful engineering, and was quite expensive. The flume is on trestles varying in height from 6 feet to 90 feet; in places it rests on galleries blasted out of the sides of the rock canyon, hundreds of feet above the bottom. Three tunnels were driven through spurs of rock, and it is one of the sights which strangers come to view.

McShane & Co. have also opened many miles of road through forests and mountains which until then were impassable; one piece of their road, between 5 and 6 miles in length, is so well made it would be a credit to any old settled community as a public road. As an incident of their business, they placed at their principal camp on Tongue River a sawmill of large capacity and modern construction. They built this mill to saw the lumber required in constructing the flume, and also sawed a little timber for the railroad. They brought down some logs to the mill by the flume, and sent down by the flume to the railroad the lumber sawed. The mill is idle, and likely to remain so, as there are but few logs to be obtained large enough to saw, and none suitable for making lumber for any but local uses, and the local demand for lumber is so small that it is easily supplied by the few small mills enumerated above. The 800,000 to 900,000 feet annually produced by the three mills selling in Sheridan Valley is a full supply; and the quantity, about the same, manufactured by the three which sell in the Bighorn Basin is quite enough to supply the demand there, and, indeed, would be an excess but for the circumstance that the new county just created, Bighorn, lying west of the mountains, has its county seat established at Basin City, and as Basin City is yet to be built, there is a little more demand for lumber than usual.

MINING.

There has been more or less prospecting for minerals in these mountains for several years, but there has been no "mining boom."

Indications which prospectors consider favorable have been found, and in many places parties are tunneling and sinking shafts to develop what they expect will be paying mines. No valuable deposits of gold have yet been discovered, but a good deal of work is going on upon indications of gold, copper, platinum, and other metals.

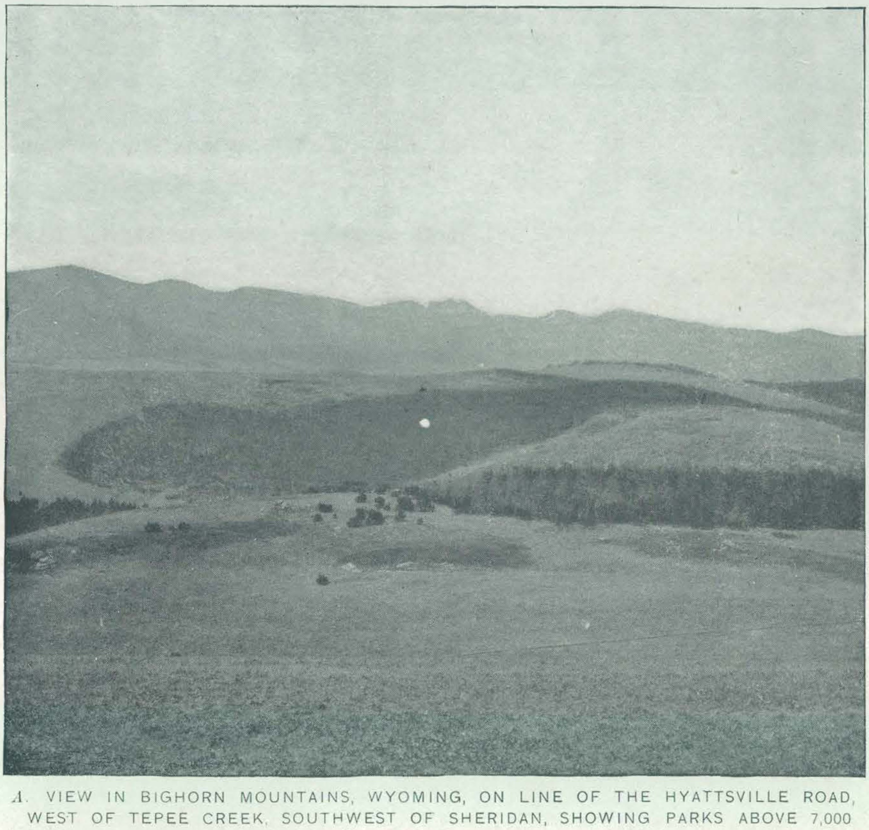
The Fortunatus Company, of New York, has been at work at Bald Mountain for some years, and has invested between $200,000 and $300,000 in its plant and work; as yet it has found nothing valuable, but the manager believes he will reach valuable deposits this winter. He is now prospecting with diamond drills.

Near the head of Piney Creek operations are being carried on to develop mines which were at first supposed to be valuable in platinum. Experiments with the rock from this mine have been carried on for a year past by some of the people connected with the Edison Electric Company, who now believe that they can obtain from it a material, which they call "slag," of exceptional value for the insulation of underground electric wires. The company has recently sent to the mine a superintendent and experts, has placed some machinery in position, and has employed a force of miners. It is thus working systematically to develop the mine, which it expects will prove very valuable.

Near Cloud Peak some Englishmen are working on several leads which they think valuable for gold. Near Black Mountain operations are being conducted on mines which the prospectors think will prove to be rich in gold. On Tongue River, shafts are being sunk to develop mines which are believed to be rich in copper. On Wolf Creek prospectors have discovered what they think will prove rich copper mines. Quite recently it is reported that searchers have discovered the "Lost Cabin" mine, the existence and fabulous richness of which have been traditions among these people for many years, and the search has continued year after year. This discovery is in the foothills off from the southwest portion of the reserve. A company has been organized and is working now on the development of the mine, and appears to feel very enthusiastic over its prospects. In all these localities and many others every acre for miles around has been staked off in claims.

The general opinion of experts appears to be that valuable deposits will be found here, but that prospectors have not yet gone deep enough to find deposits in paying quantities. If the expectation should be realized and paying deposits should be found in these mountains, there would be a rush of miners and prospectors here, and the opening of many mines would create an imperative demand for much timber. There is no other source from which it could be obtained, and there is enough here suitable for the purpose to supply the requirements, if properly used and economized.

I suggest the advisability of a regulation which would require miners and others to use, as far as practicable, first the dead timber. For all mining purposes sound dead timber is quite as good as green



A. VIEW IN BIGHORN MOUNTAINS, WYOMING, ON LINE OF THE HYATTSVILLE ROAD, WEST OF TEPEE CREEK, SOUTHWEST OF SHERIDAN, SHOWING PARKS ABOVE 7,000 FEET ELEVATION.

B. BIGHORN MOUNTAINS, WYOMING, VIEW OF LITTLE BALD MOUNTAIN FROM THE EASTWARD.

timber, and for fuel the dead, even if not sound, would answer. It would be better for the forest if cleared of this deadwood, and, besides, the living young timber would be left to grow to maturity.

IRRIGATION.

All the available water of the streams flowing out on the eastern side of these mountains is utilized to irrigate the lands in the Sheridan Valley. There is a very large area which is so irrigated, as well as some land in the Bighorn Basin which gets irrigation water from the streams flowing out on that side.

It is obvious that these lands would be worthless without irrigation, and unless the supply of water is maintained irrigation will be impossible. It is also well known that if the sides of the mountains should be denuded of timber the water supply would inevitably be cut off and the lands become worthless in consequence.

The branch of the Burlington and Missouri River Railroad is now shipping east, I am informed, from 100 to 250 carloads of cattle per day, besides a large amount of grain and other farm produce. This is from a district dependent upon these mountains for water, and unless that can be maintained prosperity can not continue.

GRAZING.

The parks in these mountains heretofore spoken of afford good pasturage for stock during the summer. There are but few cattle, and those only in the northern portion of the reserve. It is estimated by stockmen of the vicinity that this summer there were about 3,000 head of cattle ranging in the mountains in the parks north of Tongue River toward Bald Mountain, and a very few horses have also been kept on this range. These cattle are mostly owned by small ranchmen living in the Bighorn Basin, west of the mountains; they are kept up in the parks about three months, but some seasons may remain longer. It is supposed that the number will be somewhat increased next year.

These parks are also a favorite feeding place for sheep. Wherever I have been I have encountered large bands of sheep, more particularly in the southern part of the reserve, where the parks are larger and more numerous. These sheep raisers bring their flocks from the Bighorn Basin and the plains and commence grazing them on the foothills early in the spring, before the snow has left the mountains; as the summer approaches they go up higher, and during the summer months they graze in the highest parks. When the first light snow appears in the fall, they begin to work downward again, moving slowly toward the lower parks, and leave the foothills for the valleys only when driven away by the winter snows. In this way they secure a range for about five months, and sometimes for nearly six months, of the year.

No statistics can be obtained of the number of sheep ranging in these mountains. I have had estimates from several sheep raisers, but they were at best only guesses. The estimate which I consider most reliable is that of the State "scab inspector," who says that there are 450,000 sheep grazing in the mountains this summer. Of course, these are not all in the reserve, though they are all south of the Montana line, which is not only the boundary of the reserve, but also of the Crow Indian Reservation. There are also parks south of the reserve, and a good many sheep are grazed there, but I think it quite possible that 400,000 or 450,000 head might be grazed within the limits of the reserve. I have been informed by sheep raisers that it requires from $1\frac{1}{4}$ to $1\frac{1}{2}$ acres of such pasturage as these parks afford to support a sheep for the season, and if my estimate is correct—that at least one-half of the reserve is park—there would be about 600,000 acres available for pasturage.

There is strong antipathy between the cattle and sheep men, which has sometimes gone to the extent of open hostilities. The cattle men maintain that after sheep have fed on a range neither cattle nor horses will go on the range; that the sheep leave a scent which is offensive to cattle and horses, and that they eat so closely as to destroy the roots of the grass. Probably this is partly true. I know that sheep taint the air and ground with offensive smells, and that they eat very closely; but still, as a matter of fact, they continue to graze over the same pastures year after year, which they could not do if they actually destroyed the roots of the grass the first year they occupied the pasture. In justice, the sheep man's side of the case is also to be considered.

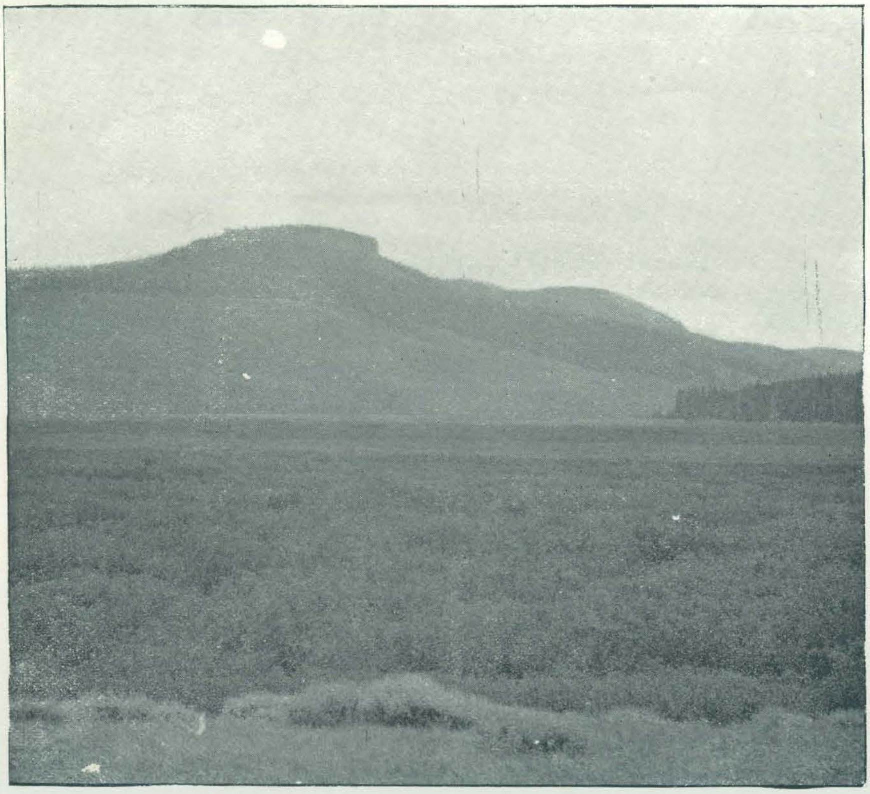
Sheep raising, both for wool and for mutton, is a very important and a rapidly increasing industry in Wyoming. These mountains seem to be very well adapted to grazing sheep. The only cattle which can come into them are the small herds of the ranchmen in the basin; all the great cattle companies have moved away, and these local herds of cattle can never be large in numbers. If we take this season's numbers as a basis, we should estimate the value of cattle and sheep on the range as follows:

3,000 head of cattle, at $30 per head average	$90, 000
450,000 head of sheep, at $2.50 per head average	1, 125, 000

Thus, the value of cattle using the range is but 8 per cent of the value of the sheep using it.

There is another point to which I desire to call attention in this connection. I have been informed that in the regulations governing timber reserves it is the purpose to prohibit the pasturing of sheep because it is believed that they eat off trees just springing up and also gnaw the bark of young trees and kill the growing timber. I have had excellent opportunity to look into this. I have found sheep in almost every park in the mountains, and I have examined most carefully through the timber surrounding the parks after they had been occupied by sheep, in every part of the reserve, and I have been unable to find

A. VIEW IN BIGHORN MOUNTAINS, WYOMING, ON LINE OF THE HYATTSVILLE ROAD, WEST OF TEPEE CREEK SOUTHWEST OF SHERIDAN, SHOWING PARKS ABOVE 7,000 FEET ELEVATION



B. UPLAND PARKS, ABOVE 7,000 FEET ELEVATION, NEAR HEADWATERS OF TONGUE RIVER.

the least evidence of the correctness of this belief; I have been unable to find so much as a single leaf or twig of a pine or spruce tree, large or small, which has been bitten or touched by them, or the smallest mark or the least abrasion of the bark on any pine or spruce tree of any size, caused by them. Hence, so far at least as this reserve is concerned, I am obliged to testify that this charge against the sheep is not well founded.

It may be possible that this belief was originated by cattle men who were first in the field to make use of the great ranges on the public lands; that, desiring to head off competition by sheep men and thus keep the ranges entirely for their own use, they made these charges, which there was no one to controvert, and have reiterated them until they are accepted as true because of frequent repetition. I do not assert this, I only suggest it as a possible explanation of a prevalent belief which I can not find facts or proofs to substantiate.

PUBLIC SENTIMENT.

I have found among the people with whom I have come in contact a considerable feeling of resentment or hostility to the establishment of a timber reserve in these mountains. This has arisen from ignorance and misapprehension of the purpose of such action by the Government. The opinion has prevailed that when a reserve was established it became in a manner sacred. They believed that no one would be permitted to enter it to prospect or to work a mine or to take necessary timber, or for any purpose whatever. I have explained to everyone with whom I have had the opportunity to converse on the subject the real purpose of the Government in setting apart these reserves, and the effect of doing so; that no existing privileges are in any way abridged, and that the only real restrictions imposed are that timber shall not be stolen for private gain, burned up, or recklessly wasted; and in every instance when the true facts are understood the citizen has become convinced of the advantage to him and to the community which would result from such action, and has become warmly in favor of it.

The opinion is generally entertained among farmers here that they can not compete with other States in the production of export crops; that the cost of irrigation, which here is indispensable, renders them unable to market a crop of wheat, corn, or hay as cheaply as can be done in States which raise their crops by means of rainfall. This is certainly true. These farmers maintain that if they could have a local market for their produce it would enhance the value of their lands many fold and bring them a greater degree of prosperity. To this end all are hoping for the development of valuable mines in these mountains, which would induce a large inflow of prospectors and operators; and therefore every promising discovery is eagerly welcomed by the farmers. It is to be hoped, for the sake of the community, that discoveries may soon be made which will bring a large number of operators to the mountains.

CONCLUSIONS AND RECOMMENDATIONS.

I have been greatly disappointed in what I have found in this timber reserve. I expected to find at least a reasonably good stand of timber of good quality. This expectation has not been realized.

The limits of the reserve inclose about 1,250,000 acres. Of this I estimate that 50 per cent is park. A very considerable part of the remainder is barren rock and land covered with the débris of fires, and most of the growing timber is too small for use for some time to come. Less than 10 per cent of the area of the reserve bears timber large enough for present use, and of this area, which is classed as merchantable timber, the amount of such timber—only an average of 2,500 feet per acre in board measure—is so small that it might all be cut out without changing the appearance of any portion of the reserve. And further, the timber which is large enough for use is so poor in quality and so full of knots that it could only be used where nothing else was obtainable.

Such is the present status of the reserve. For present use it has practically no value if considered merely from a commercial point of view. The only timber from which any revenue could be derived would be that very small quantity used by the local sawmills, and that quantity, also not large, which might be converted into railway ties, and this would be contingent upon some railway in the vicinity requiring ties and some contractor willing to incur the expense of providing the necessary appliances to get them out. There is no timber now in the reserve from which the lumber obtained could be sold in any market where other and better lumber could be procured.

But there is another view to be presented which is worthy of the most serious consideration. If this reserve is treated as a nursery of timber for future use, it becomes a most valuable possession. Only the Federal Government could so hold it as the trustee for future generations, but so to hold it would be a public benefaction of value which can not now be estimated.

There is a somewhat extensive district lying between these mountains and the next timber-bearing region which now has a considerable population, and the population is increasing. These people must have lumber, and there is no other that they can get. These people also depend upon these mountains for water for irrigation, without which their land would be a desert. The young timber, and even the débris and waste left in the woods in lumber operations, are as useful in holding the snow and retarding the flow of water as larger timber would be. Unless this forest is preserved the neighboring country will become uninhabitable for want of the two most essential requirements, water and timber; and the forest can not, in all probability, be preserved unless it is placed under regulations and supervision of the Government, to prevent forest fires and the waste of timber.

There can be no reason to doubt that sometime in the past these mountains bore a good stand of good timber. The present stunted, knotty trees constitute the growth which has come up from the wreck of fires of long ago, which had so far destroyed the soil as to deprive the trees of necessary nutriment, and the result is the scrubby and impoverished growth we now see.

The present stand of timber, while it will supply local needs for farm uses well enough, is fit for but one use from a commercial point of view, as stated before—making railway ties—in which knots constitute no objection, and for which the largest trees are of about suitable size. If these trees were or could be all cut out of the forest, it would be a benefit to it by giving the younger and better trees room to grow.

The young timber is mostly standing in very thick growths, which will cause it to develop long stocks, more clear of knots, and of better grain, provided that fire can be kept out. Every year the litter of leaves and cones falling and decaying on the ground will add something to the soil, and so the humus will become gradually deeper, holding more moisture and nourishing a better growth. Then under a wise and practical forestry system the excessive stands would be thinned out and gradually it would develop into a forest of good timber. Much if not all of the park area would become timber land by the natural encroachment of the timber upon it, and this might be assisted by spreading seeds there. Many of the now barren hillsides would again become timber bearing, for even now young saplings are springing up among the ruins of fires, and the decay of the burnt timber lying on the ground would furnish a small capital of soil to assist the growth, which the young growing trees will add to year by year from their own litter.

The growth of a forest is not a thing to be accomplished quickly, and here there are disadvantages of season and climate to make the process slower; but the growth may be obtained, and it appears worth obtaining.

If it should be decided to take this forest under protection of the Government and hold it as a reserve, in due time it would become a forest of such quantity and quality of timber as would supply for all time the wants of as large a population as is likely to depend upon it; and if, as is expected, valuable mines should be developed in these mountains, the preservation of the timber would be vastly more beneficial, not only to the miners, but in a greater degree to the farmers, who would find among the miners a market for their produce, and thus increase the value of their lands and greatly promote their prosperity.

I think it would tend greatly to the improvement of the forest and would result in the earlier attainment of a good growth of valuable timber if, as far as possible, a policy should be adopted which kept in view these objects:

(1) To clear the forest as rapidly as possible of débris as well as of undesirable growth.

(2) To protect and promote the growth of the young timber now growing.

(3) To increase the timber-bearing area.

It would be working in this direction if regulations were established something like the following:

(1) Requiring all persons who may be permitted to take timber from the reserve, whether for farm uses, building, mining, fuel, or any other purpose, to use as much as possible the sound dead timber, whether standing or fallen, preferably the fallen, thus permitting the living trees to grow. The rotting wood will finally decompose, add to the soil, and so aid the growth of the young timber.

(2) Encouraging the removal of trees large enough for use for milling or other commercial purposes, especially those which are very knotty and those which are not sound the entire length of their trunk, and dead trees which are sound, by offering such trees from time to time for sale to buyers who would cut and remove them. This suggestion is based on the supposition that the Government would have employed to care for the reserve men who could select and mark such trees as it was desirable to have removed, and who could also see, if they were sold for removal, that the same trees and no others were the ones actually taken. The revenue from this would not be large, it is true, but it would be something; and if such trees could be cut out it would make room for the growth of the young timber among which they stand; and this young timber will make so much better lumber when it matures, as it will develop a longer stock and be freer from knots, that it would be an advantage to get this old, knotty, and dead timber out of the forest, even if it produced no revenue, for the improvement in the character of the remaining timber.

(3) Requiring farmers or others taking timber for domestic use—logs for house building, poles for corrals, fencing, etc.—to cut them from the thick growths, so as to thin out the forest to that extent and promote the growth of the trees left standing. At the present time the method is to cut where it is most convenient for hauling and clear off a tract entirely, leaving nothing to grow.

(4) Forbidding the cutting of any green tree for fuel, except jack pine, until all the dead timber has been removed, both that standing and that on the ground. The jack pine is worthless for any purpose except fuel, and may as well as not be used for that; but in many cases if the dead timber was farther to haul, the wood getters would cut young, green timber rather than to go farther to get the deadwood.

These restrictions seem to give every possible protection to the forest against those who would come to take out timber. It is evident that these regulations could not be enforced without the presence of a police body who could and would compel their observance; but it is presumed that no timber reserve would be established without the employment of such a force. These men should be so intelligent and efficient, and so well disposed to carry out the instructions of the Department which employs them, that they would make every transaction, no matter how small or how great, contribute in some degree to the improvement and preservation of the forest by constantly having removed what was detrimental and fostering what was beneficial.

The proper officers would, of course, make such regulations as they deemed wisest and prescribe the duties of forest employees, but I think they might well be charged with the duty, under proper supervision, of judiciously thinning out the excessive stands of young timber and spreading the seeds of timber trees over the parks and barren mountain sides, as well as the most important police duty of all—guarding against fires and arresting and prosecuting those who carelessly or maliciously cause fires or who violate the regulations of the reserve in taking out timber.

There are those who believe that they have a right to do as they please in a forest because they have always done so, and who resent any attempt to curb their lawlessness as an infringement of their independence. A little stern administration of justice to the unruly, and patience with the well-disposed until they can learn the workings of the regulations, will teach all that the Government is their benefactor in protecting their timber and water, allowing them free use of it for legitimate purposes and forbidding only its pilfering and waste. All these matters are of the greatest importance in order to secure in the future a forest which will be valuable.

If in the event of a reserve being established it should be deemed advisable to permit the cutting of timber for any commercial purposes, of course regulations would necessarily be made for the disposition of the tops and refuse, to guard against danger of fire. I have been asked by many what would be required in this respect, and could only reply that I could not say, for I did not know what would be the views of those having authority on such points. It would manifestly be impracticable to burn such débris where it fell, for that would cause forest fires; neither would it be practicable to require it to be hauled away to be burned outside of the forest, as that would impose a cost upon the operators which would make lumber operations impossible. The cost of hauling is one of the heaviest items of lumbering, and as the tops and waste would amount to several times as much hauling as the salable material, and as it would have to be hauled long distances to get it outside of the forest, it would make the cost more than the lumber would sell for.

I think a fair degree of safety might be secured by requiring cutters to lop off standing limbs, so that all débris would lie flat on the ground. This would not impose any hardship on them, and would, I think, insure as great a degree of safety as can well be obtained. Nothing but constant watchfulness and care can guard against fires, and if they should be permitted to get under headway it would make but little difference, I think, whether they had only the growing timber to feed on, or, in addition, the débris of lumbering operations. In either case the forest would be effectually destroyed.

A system of surveillance and responsibility to authority well arranged and rigidly enforced can prevent fires, and if this is accomplished nature, wisely assisted, will produce a good forest, even here, in her own time and by her own methods.

TETON FOREST RESERVE.

From notes by Dr. T. S. Brandegee.

LIMITS.

This reserve is situated in western Wyoming. Its limits, as defined by Executive order of February 22, 1897, are as follows:

Beginning at the southeast corner of township forty-three (43) north, range one hundred and ten (110) west, sixth (6th) principal meridian, Wyoming; thence northerly along the surveyed and unsurveyed range line between ranges one hundred and nine (109) and one hundred and ten (110) west, to the point of intersection with the south boundary of the Yellowstone National Park Timber Land Reserve, as established by proclamation of September tenth, eighteen hundred and ninety-one; thence westerly along said boundary to its intersection with the boundary line between the States of Wyoming and Idaho; thence southerly along said State boundary line to the point for the unsurveyed township line between townships forty-two (42) and forty-three (43) north; thence easterly along the unsurveyed and surveyed township line between townships forty-two (42) and forty-three (43) north, to the southeast corner of township forty-three (43) north, range one hundred and ten (110) west, the place of beginning.

In brief, its limits are, on the east, the range line between ranges 109 and 110; on the north, the parallel of 44° north latitude; on the west, the west boundary of Wyoming; and on the south, the south boundary of T. 43 N., R. 110 W. The area herein included is estimated at 1,300 square miles, or 829,440 acres.

This area has been mapped by the Hayden Survey and the United States Geological Survey on a scale of 4 miles to the inch, a scale too small for the representation of details of topography or forest characteristics, but sufficiently large for the presentation of the broader facts of distribution.

The forest conditions of this reserve were examined by Dr. T. S. Brandegee, the well-known botanist, of San Diego, California, who devoted nearly three months to the examination of this reserve and that portion of the Yellowstone Reserve lying south of Yellowstone Park. This report has been prepared from notes furnished by him.

TOPOGRAPHY.

The principal relief features are simple. Traversing the reserve from north to south, near its western boundary, is the Teton Range, descending rather steeply to the west into the valley of Pierre River, the eastern portion of which is included within the reserve. On the east the mountains descend by a precipitous wall to a broad valley, Jackson Hole, which also traverses the reserve from north to south. East of Jackson Hole the land rises in great, broad mountain spurs to the Wind River Range, whose summit is beyond the limits of the reserve on the east. The area is drained by Snake River and its tributaries southward and westward.

The Teton Range has an average breadth of 12 to 15 miles, and extends northward and southward beyond the limits of the reserve. Its greatest altitude is in the well-known summit, the Grand Teton, which rears its head far above its fellows to an altitude of 13,870 feet. The average altitude of the range probably does not exceed 12,000 feet. The mountains are extremely rugged and rise high above timber line, which is here at an altitude of about 10,000 feet. The only practicable pass in the range is Teton Pass, with an altitude of 8,464 feet. The range has been deeply eroded by glaciers, as well as by water, and there are still in existence several small glaciers occupying little basins high up in the range.

From the crest the range descends quite steeply to the valley known as Teton Basin. The western boundary of the reserve includes in the north a considerable area of this valley, but as the range trends slightly to the westward the strip of valley land diminishes in width southward, so that at the south boundary of the reserve the west line crosses the foothills of the range. The altitude of the valley within the reserve lines ranges from 6,500 to 7,000 feet, an altitude which in this latitude is prohibitive of profitable cultivation except of the hardiest crops, such as potatoes, oats, hay, etc. This valley portion is watered and drained by streams flowing westward to Pierre River from the mountains.

On the east the Teton Range descends, by cliffs and slopes of the most rugged character, to the valley known as Jackson Hole. This is a broad expanse extending from the north boundary of the reserve, in a direction a little west of south, to the southern limit. It has a breadth ranging from 10 to 20 miles, while its altitude within the reserve ranges from 6,500 to 7,000 feet, which, as in the case of Teton Basin, indicates a climate too rigorous for any but the most limited agriculture.

Snake River enters this valley on the north and shortly runs into Jackson Lake, a large body of water 10 miles long by an average of 3 miles in breadth. The river leaves the lake at its southeast angle, and flows at first northeastward, then southeastward, and finally southwestward down the valley, receiving on its way, among other streams, Buffalo and Gros Ventre rivers from the east, and a number of small streams from the west. At the east base of the mountains there is a succession of smaller lakes, among them Lee and Jenny lakes, which are connected, and from which flows Lake Creek to the Snake, and farther south Taggart and Phelps lakes.

The surface of the valley is in the main a gravelly bench land, level, and producing a scanty growth of sagebrush interspersed with a little

TETON RANGE, WYOMING.

grass. This bench land terminates with low bluffs, inclosing the bottom lands of the river. These are broad, and through them the river has a very winding course. These bottom lands are covered with a forest of cottonwood and willows, with a dense undergrowth. The river has great volume at all stages of water, is remarkably uniform in its flow, owing to the existence of a natural reservoir, Jackson Lake, and has a fall amply sufficient to bring the water up to the higher portions of the bench land. Indeed, were it not for the severity of the climate, this would form a valuable agricultural region, as there is an abundance of water for irrigation throughout its entire extent.

The northernmost affluent of Snake River from the east is Buffalo River. This stream heads in high volcanic plateaus east of the reserve, which form the northward extension of Wind River Range. Its general course is westerly to its junction with the Snake. It is a rapid stream, and flows, through most of its course, in a narrow valley.

North of Buffalo River most of the country is rolling and undulating, not greatly elevated above the level of the river; but it contains numerous isolated fragments of a high plateau about the heads of the streams, many portions of which have been eroded away, and these fragments are left, appearing as isolated hills and mesas.

South of Buffalo River, between it and the Gros Ventre, is a high, broad spur stretching westward from the summits to the east. The highest point in this spur is not far from its western end, and is known as Mount Leidy, which has an altitude of 11,177 feet. This broad spur or mountain mass is drained mainly by the tributaries of Gros Ventre River, the streams flowing to Buffalo River being comparatively short.

Gros Ventre River also heads in a high volcanic plateau, and flows with a generally westerly course to its junction with Snake River.

CLIMATE.

So far as I am aware, no observations of rainfall have been made within this area. There is every indication, however, that the rainfall upon the Teton Range and upon the mountain spurs east of Jackson Hole is heavy, especially upon the west slopes of the former range. The existence of glaciers is in itself an indication of a heavy precipitation. The streams flowing from these ranges are large in proportion to their drainage basins, which is another indication of copious rainfall.

In Jackson Hole and Teton Basin, on the other hand, the rainfall is deficient, being inadequate for the needs of agriculture. What little farming is done in these valleys requires irrigation, except in a few localities where the soil is naturally supplied with water by percolation from the streams.

No observations for temperature, so far as I am aware, have been made within this region; but that it is cold, almost subarctic in temperature, may be inferred from the altitude and latitude. The lower portions of the reserve are at an elevation of 6,500 feet, and from that he valley, habitable portions range up to 8,000 feet. The experience of the limited agricultural operations which have been carried on has been sufficient to show, as stated above, that only the hardiest garden vegetables, grains, and forage plants can be cultivated.

AGRICULTURAL LANDS.

As stated above, the west boundary includes a small area in the upper, higher part of Teton Basin. This is a triangular tract, widest at the north, where it may be 6 miles wide, and diminishing southward to a point. Nearly all of T. 45 N., R. 118 W., is within this area; also the west half of T. 44 N., R. 118 W., and two western tiers of sections in T. 43 N., R. 118 W., are included within this tract. Although elevated and cold, and therefore capable of producing only the hardiest crops, all this land is susceptible of irrigation.

Jackson Hole comprises a large amount of agricultural land. It is well situated for irrigation, and the supply of water is ample for the entire area. The altitude is, however, great, and the consequent severity of the climate prevents the production of anything but the hardiest vegetables and grains. The value of the land for agriculture, therefore, is not great. The area included in this basin which may be taken out of the reserve on the ground of its greater value for agriculture than for the production of timber is as follows:

R. 113 W., T. 46 N., three western tiers of sections; T. 45 N., south half.

R. 114 W., Ts. 46, 45, 44 (north half) N.

R. 115 W., Ts. 46, 45, 44, 43 (west half) N.

R. 116 W., T. 44 N., two eastern tiers of sections; T. 43 N., east half.

Access to the valley is not easy. From Teton Basin, on the west, a wagon road has been built over Teton Pass (8,484 feet), over which the mail is carried. This constitutes the principal means of access. From the north end of the valley a trail runs up into Yellowstone Park, and another westward around the north end of Teton Range into Falls River Basin. From the east, connection is had with Wind River Valley via Union Pass, at an altitude of 9,516 feet, and Gros Ventre Pass, at an altitude of 9,852 feet, and Buffalo River. From the head of Green River Basin a trail leads to Snake River, at the foot of Jackson Hole, through the canyon of Hoback River. The canyon of Snake River at the foot of Jackson Hole is impassable.

GEOLOGY.

The geologic features of this region are very complicated. The entire geologic series is represented, together with a variety of metamorphic rocks and volcanic rocks of all ages.

Teton Range is a monocline, faulted on the east and dipping westward. The body of the range is composed of metamorphic granite.

TETON RANGE, WYOMING.

Stratified beds which originally overlay this have in great part been removed, but upon the summits of certain of the westward spurs patches of Silurian still remain. Lower down Silurian beds lie up against the range continuously from the south end northward for three-fourths the length of the range. Still lower down upon the mountain flank Carboniferous beds overlie Silurian beds, and near the south end of the range Juratrias beds succeed them. Just above the edge of the valley of Teton River a low, narrow belt of basalt covers the whole breadth of the valley and extends northward up to the granite upon the range, covering all the stratified beds. At the north end of the range the stratified beds curve around over the granite, showing a succession of Silurian and Carboniferous beds. The central portions of Teton Basin are floored with Pleistocene deposits to a great depth.

Jackson Hole occupies the bed of the fault, and is, like most of Teton Basin, filled to a great depth with Pleistocene deposits. In its southern portion are two groups of buttes, known, respectively, as Upper and Lower Gros Ventre Buttes. The former exposes rocks of Silurian, Carboniferous, and Tertiary ages, while the latter, with a volcanic nucleus, exposes stratified beds of the same ages.

East of Snake River the central geologic phenomenon is the elevation of the Gros Ventre Range. This is a short range, trending northwest and southeast, separating the Gros Ventre and Hoback rivers. It lies, therefore, entirely south of the reserve. It is a short anticlinal uplift, with a nucleus of granite, and with stratified beds dipping away from it to the northeast, to the southwest, and to the southeast, around the end of the range. The succession of rocks to the northeast shows, first, a narrow outcrop of Silurian beds, then a broad outcrop of Carboniferous rocks, along the edge of which flows Gros Ventre River through a part of its course. Succeeding this is an equally broad outcrop of Juratrias, whose margin is followed by Gros Ventre River during another part of its course. Succeeding this to the northeast are Cretaceous and Tertiary beds, of which the great mountain spur separating Buffalo River from the Gros Ventre is composed. The other portions of this spur are formed by Tertiary beds.

The country about the head of Gros Ventre and Buffalo rivers is capped by an outflow of volcanic rock lying directly on top of the Tertiary beds, thus protecting them from erosion.

FORESTS.

Although, with the exception of Jackson Hole and the other small valley areas above described and the mountain areas above timber line or too rugged for timber growth, this region is one in which the climatic conditions favor forest growth, yet it contains but little forest. Only a fraction of its area, probably not more than one-fourth, is covered with trees, and most of these are young, small, and of species of little value for lumber. It is only occasionally that tracts of timber of merchantable size are found, and areas containing notable quantities of merchantable forests are few and limited.

This condition appears to be due simply and solely to fires which have swept over the country so completely and persistently that scarcely any part has been entirely exempt from them, while nearly all portions have been burned again and again within a generation. A large proportion of the area has been burned so persistently and frequently that the forests have ceased, temporarily at least, to attempt to restore themselves, and these regions are now grass-covered parks. Indeed, the forest conditions in this reserve closely resemble in all respects those of the Bighorn Mountains. Some areas have been repeatedly burned, so that *Pinus murrayana*, or lodgepole pine, the most abundant conifer, seems to have been driven out. Such areas will naturally become covered with aspen in time, for aspen seeds can be carried great distances by the wind, while lodgepole-pine seeds can not spread far from the parent tree except by the aid of birds, squirrels, rats, etc. Under present conditions the tree-bearing regions as a whole decrease, while the aspen areas increase at the expense of those now producing conifers. With few exceptions young trees are springing up over the recently burnt districts, and in most places are abundant. The young growth of lodgepole pine is usually very dense, and even impassable.

The timber which is of merchantable size and quality is for the most part scattered over the reserve in small groves or individual trees in such wise that except in a few localities, distinguished by the deeper color upon the map, it could not be cut economically. These few localities are specified in the detailed descriptions which follow. Altogether they are estimated to contain 22,180 acres, or about the equivalent of a township. Thus only about 3 per cent of the area of the reserve is covered by merchantable timber in anything like compact bodies. These areas are estimated to contain about 75,000,000 feet B. M.

The entire area of the reserve is approximately 1,300 square miles. Of this, 300 square miles are without timber, because of great altitude or the rugged character of the country, 250 square miles of this being rugged portions of the Teton Range, and the remainder is comprised in the elevated summits of the volcanic plateau on the eastern border of the reserve. In the Teton Basin there is an area of about 25 square miles within the reserve which is naturally timberless, and in Jackson Hole there is a similar area of 150 square miles. These two areas probably never will produce timber, on account of deficient rainfall. In addition to these are the areas of Jackson and other lakes, estimated to comprise 40 square miles. There is thus altogether an area of 515 square miles, or 40 per cent of the entire area of the reserve, which is not only without timber at present, but is in all probability incapable of supporting a timber growth. Of the remaining 785 square miles, all of which is believed to be capable of producing timber, only 38 per cent at present has a growth of timber upon it, and only 3 per cent of the latter area contains timber of merchantable size and quantity.

These areas of merchantable timber, which, as stated above, comprise in all the equivalent of about one township, contain an estimated amount of 75,000,000 feet B. M. of timber. If the entire area of 875 square miles were timbered as heavily as are these few areas, the reserve would contain about 1,000 million feet instead of 75 million. The difference between these two numbers represents the destruction by fire.

SPECIES OF TIMBER.

The timber trees found on this reserve are *Pinus murrayana*, which forms the bulk of the forest; aspens, next in abundance, *Picea engelmanni*, *Abies lasiocarpa*, *Pinus flexilis*, and, finally, the cottonwoods. Their relative abundance and distribution are shown below.

PINUS MURRAYANA. (Lodgepole pine.)

This comprises four-fifths of the Coniferæ. It is here a small tree, rarely 2 feet in diameter and 75 feet high. When growing alone a tree commonly bears limbs low down upon the trunk, but in a forest and growing close together it may have a clear trunk for 30 feet. It covers large areas, to the exclusion of all other trees, and then its trunk is rarely more than 8 to 12 inches in diameter, although 50 to 75 feet high. It grows from the lowest elevation to 8,000 or even 9,000 feet, but is more plentiful at the lowest and middle elevations. The dead, dry logs of these trees furnish material for the log houses and fences of the inhabitants. The larger ones are culled out by the sawmills and known as "bird's-eye" pine. The boards made from it are white and full of knots.

PICEA ENGELMANNI. (Engelmann spruce.)

The habitat of this tree is along streams between elevations of 7,000 to 10,000 feet. It is in some places abundant and seems to furnish most of the logs for the sawmills. A large tree may be 3 feet in diameter and 125 feet high. Its habitat and situation on damp soil often prevent its destruction by fire.

PSEUDOTSUGA TAXIFOLIA. (Red fir.)

This is nowhere very abundant. It grows usually on dry ridges, and since much of it survives the fires it is probably more abundant than if the rest of the forest had not been destroyed. It is especially prominent on the west side of the Teton Range above Lee Creek. The largest trees are 3 feet in diameter and more than 100 feet high. It is not sufficiently abundant to be of any value as a timber tree.

POPULUS TREMULOIDES. (Aspen.)

The aspen, after *P. murrayana*, is the most common tree. It grows from the lowest elevation to 8,000 or 9,000 feet. Large trees become nearly 2 feet in diameter and 50 feet high. It is especially abundant at the lower elevations along the edge of the Coniferæ. It is usually small, and in very few places becomes large even for this species.

Populus angustifolia. (Aspen.)

This tree grows only along the streams in the valleys. It is abundant along Snake River, Spread Creek, and Pacific Creek, and is found also on the streams west of the Teton Range. The trees grow to 3 or 4 feet in diameter and 75 feet high. On the west side, where it is difficult to get *P. murrayana*, these trees are used for fencing. Following the streams it extends farther than the Coniferæ into the agricultural areas.

Populus trichocarpa. (Cottonwood.)

This is not common. It is usually found with *P. angustifolia.* A few trees grow along Spread Creek, more about Jenny and Taggart lakes and on the western side of the Teton Range.

Juniperus communis. (Juniper.)

This juniper is very uncommon; only a bush seen now and then, perhaps two dozen altogether.

Juniperus virginiana. (Red juniper.)

Very little of this tree is found. About Menirs Ferry some posts of it have been used about the ranch.

Pinus flexilis.

This species grows in exposed situations, and rarely covers any area. There are some good-sized forests south from Togwotee Pass. The species is usually common near the timber-line region, along the summit of ridges. Sometimes a solitary tree grows out on the plains. It is not used for lumber because of its inaccessible habitat and its short trunk.

Abies lasiocarpa.

This is most abundant about the timber line on northern slopes, and sometimes follows the streams down to the lowest elevations. The largest trees are 2 to 3 feet in diameter and 100 feet high. It is considered worthless for lumber. The bark is thin and the tree is thus easily killed by fire, but as it generally grows in moist situations much escapes burning.

UNDERGROWTH.

Pinus murrayana woods never have a very heavy undergrowth, and it is often entirely wanting. There is little humus in these forests. The most abundant vegetation growing under *P. murrayana* is "pine grass," a grass not relished by stock. In moist situations Lonicera is common, with Ribes, Shepherdia, etc. Two or three species of shrubby Artemisia are very abundant in almost every place where there is no forest, but in the forest there is usually very little undergrowth of shrubs. The most abundant is Vaccinium, of two or three species, in the subalpine and middle elevations. Elæagnus is abundant along the stream banks of the lower elevations. Among the herbaceous plants that are valuable for pasturage or for hay, and are abundant, Geranium and Helianthella are the most important.

Ceanothus velutinus is common east of Jackson Lake, north of Pacific Creek, on the east slope of the Teton Range, and west of the range. This bush is at times conspicuous on areas burned several years previous. *Sphæralcea acerifolia*, a showy malvaceous plant, soon appears in a burnt district, with Epilobium, etc.

DETAILED DESCRIPTION.

The classification of the land of the reserve is shown on the accompanying map (Pl. XLIII). In this are represented lands which under a favorable climate would be agricultural—that is, they are open valley lands. The areas covered by coniferous timber are indicated by tint of one color. The lightest shade, covering most of the timbered area, represents young growth, or that of nonmerchantable size or abundance. The second tint represents areas covered by timber of merchantable size and sufficiently abundant to cut 2,000 feet B. M. per acre. The little spots of still deeper tint indicate a density of 5,000 feet per acre. Areas producing quaking aspen, willows, and cottonwoods are represented in another color and those recently burned in still another.

On this map the exterior township lines have been constructed as accurately as practicable, and the detailed descriptions will be made with the township as a unit. The reserve includes townships 43 to 46, inclusive, in ranges 110 to 118, inclusive—in all, 36 townships.

T. 46 N., R. 110 W.—This township lies close to the high mountain divide separating the waters of Wind River from those of the Snake. It is composed of high, rugged, plateau-like mountain spurs, between which are the heads of streams flowing to Buffalo River. The altitude ranges from 8,000 to 11,000 feet. There is very little timber, and that is on the lower slopes of the valleys of the streams, the summits of the ridges and plateau being bare.

T. 46 N., R. 111 W.—The eastern part of this township is made up of spurs from the Snake-Wind River divide, between which flow, in high valleys, branches of Buffalo River. The western portion is comparatively low, undulating country, in which is the valley of the North Fork of Buffalo River. The altitude ranges from 7,500 feet up to 10,000. The timber is scattering. The undulating country of the western portion is covered by groves alternating with parks. Upon the lower slopes of the high mountain ridges there is scattering timber.

The ridge rising in the southeastern portion of the township is well covered with forests.

T. 46 N., R. 112 W.—The country is high and rolling, with an average altitude of about 8,000 feet, and is drained by the waters of Pacific Creek and those of Buffalo River. The slopes to Pacific Creek, in the northern part of the township, are fairly well timbered, while upon the drainage to Buffalo River, which occupies the southern two-thirds of the township, timber is scattering, occurring only in groves upon the north slopes, and contains much dead timber. There are two small recent burns in the north edge of the township.

T. 46 N., R. 113 W.—Pacific Creek flows southwest across this township and drains the entire area. The surface presents no great relief, excepting a high, abrupt hill on the eastern edge and quite high bluffs along the creek. The altitude ranges from 7,000 to 9,000 feet. A large part of this township, perhaps one-third of it, has recently been burned. This burnt area, as indicated by the map, is east of Pacific Creek. The slopes on the south side of the creek are fairly well timbered, and timber occurs in patches elsewhere. In the southwestern part of the township there is much quaking aspen and cottonwood, mingled with young pines in the valley of the creek. The northwestern part of the township contains scattered groves of young conifers, with much dead timber standing or fallen.

T. 46. N., R. 114 W.—This township also is made up of rolling and broken country disposed rather irregularly, and is in the main drained by a small creek flowing directly into Jackson Lake. Most of its area is devoid of timber. Some quaking-aspen groves are found in the southern part and along the creek, while in the northwestern part are areas of small conifers. Three small recent burns have occurred in the northwestern portion of the township.

T. 46 N., R. 115 W.—This township contains the northern portion of Jackson Lake. The country generally is level, having an elevation of approximately 7,000 feet. Snake River enters the northwestern portion of the township and flows southward into the head of the lake. On its eastern bank is a strip of open valley country, perhaps a mile in width and 2 miles in length north and south. This is a fine meadow, from which many tons of hay have been cut this year and many more might have been cut. The soil is damp from seepage from the river, so that no irrigation is needed for the production of hay. On the west bank the river is bordered by a belt of cottonwoods. East of the lake is a mixture of pines and aspens, mainly the former, which in the northeastern part of the township becomes somewhat dense, but is entirely composed of young trees. Among them are two or three small recent burns. On the west shore of the lake is a fairly heavy growth of pines, extending from the shore back to the foot of the mountains and running up into the gulches in places for a mile or two. This area, which extends westward into range 116, contains a body of merchantable timber of more than 2,000 feet to the acre over an area of nearly seven sections.

T. 46 N., R. 116 W.—Nearly all of this township is occupied by the high, rugged Teton Range, and is entirely devoid of timber, owing to the combined effects of altitude and ruggedness. Along its eastern edge, however, the belt of timber fringing Jackson Lake extends over into this township for a mile or two near the northern line.

T. 46 N., R. 117 W.—This township is occupied by the Teton Range. With the exception of the northwestern one-fourth, it is barren. There is a strip of timber upon the western edge, consisting of young pines with some red firs and scattered aspens. This area of timber, which extends into the next township westward and southwestward, is one of the largest in the reserve.

T. 46 N., R. 118 W.—This township contains the west slope of the Teton Range. It consists of long spurs and narrow valleys running westward. The body of timber shown on the map as covering this township, the western portion of T. 46, R. 117, and the northern portion of T. 45, R. 118, is composed mainly of young lodgepole pines of various ages and sizes, from 10 feet high upward. Its distribution depends upon the topography. Innumerable small gulches and depressions run from the mountains westward. On their northern slopes and in the bottoms there is an impassable second growth of pine, with more or less fallen dead timber. Young aspens grow about the edges and on the northern slopes. On these slopes also there are often large red firs. These trees, however, are in many other places very large in proportion to other trees of the locality, because they are not killed easily by fire, and may therefore have survived several generations of aspens and *Pinus murrayana*. In some localities in this area patches of good-sized *P. murrayana* and also aspens are seen, but the trees of this species are mainly young and so dense that the region is impassable in a north-south direction. A part of this area, comprising nearly eleven sections, is estimated to contain over 2,000 feet of standing timber to the acre, of merchantable size and quality.

T. 45 N., R. 110 W.—This township presents high relief, being composed of the deep valleys of the head branches of Buffalo River, between which are high, plateau-like spurs. The sides of these spurs are partially covered with forests, while the summits and upper portions of the slopes are bare. The areas indicated as timbered upon the map are about three-fourths timber and one-fourth open park country.

T. 45 N., R. 111 W.—This township is traversed from east to west by the narrow valley of Buffalo River, and from its north boundary nearly to its south boundary by the valley of the North Fork of that river. The southern part of the township is composed of a mountain spur, separating Buffalo from Black Rock Creek, while north of Buffalo River on the east of its North Fork is another high spur. These spurs reach altitudes of 11,000 feet, and, as the valley of Buffalo River is 7,400 feet, the range of altitude in this township exceeds 3,500 feet. North of Buffalo River and west of its North Fork the country is undulating, with but slight relief.

The spur south of Buffalo River is fairly well timbered upon its north face, in small areas across its summit, and down the southern face. This timber is of commercial size, and will cut over 2,000 feet per acre over an area equivalent to two sections. In the western part of the township upon this spur is a burn covering some 4 or 5 square miles. Much of the dead timber is still standing and is mainly Engelmann's fir. This is among the largest of this species seen upon the reserve, and if not burned would have been among the largest seen upon the reserve, many trees being 2 feet in diameter and 100 feet high. If not killed by fire, this would have been one of the most valuable bodies of timber seen.

On the southern slope of the spur, north of Buffalo River and east of its North Fork, there is quite a body of timber, covering, perhaps, three-fourths of the surface. Around on the west end of this spur the timber becomes much more scattering, only a small fraction of the surface being covered by it. On the north slopes again the timber becomes close, while the top of the spur is entirely bare. West of the North Fork the undulating country contains only scattered groves of timber.

T. 45 N., R. 112 W.—This township is traversed by Buffalo River from east to west in a valley from 1 to 2 miles in width. South of it this valley is separated from that of Black Rock Creek by a low, flat ridge rising 600 or 800 feet above the valley. Near the center of the township Box Creek enters Buffalo River. On the north and east of this creek the country is undulating, presenting a slight relief. West of it is a high, symmetrical hill, lying partly in this township and partly in T. 45 N., R. 113 W. The summit of this hill is about 2,500 feet above the valley, or 9,500 feet above the sea.

The immediate valley of Buffalo River is treeless. The low, flat ridge separating it from Black Rock Creek is in part covered by scattering groves and in part by a burn of some 4 or 5 square miles. Within this township, as noted in describing T. 45 N., R 111 W., this burn is covered with standing and fallen *Picea engelmanni* of merchantable size. North of Buffalo River and east of Black Rock Creek the undulating country is covered by scattered groves, mainly of young trees. The hill lying west of this creek is covered by a scattering growth of aspens, young pines, and a few red firs, with a large amount of standing and fallen dead timber.

T. 45 N., R. 113 W.—This township is traversed from east to west by Buffalo River, which crosses it near its southern border in a valley from 1 to 2 miles in width. Were it not for the elevation, this valley would be valuable agricultural land. On the east line of the township Black Rock Creek enters Buffalo River, and near the junction is located one of the few ranches in the reserve. The soil of the valley is largely coarse gravel, in which the river has cut many courses. On the south of the valley there is a low bluff on which are scattered groves of aspen, and on the north the country rises into hills. On the east side of the township the country rises to a height of 9,500 feet above the sea. The slopes are covered with aspen groves and a scattered growth of young pines, with a few old red firs. Among this young growth many dead pines are still standing, while the ground is covered with others which have fallen. Upon the western side of the township is a second hill, rising about 2,500 feet above the valley. On this there are a few scattered groves of pine; but most of the slopes of this hill, with the flat country north of it, have been recently burned. The summit is entirely devoid of timber.

T. 45 N., R. 114 W.—In the western portion of this township is the outlet of Jackson Lake. Snake River flows at first eastward with a very crooked course to the junction of Pacific Creek, where it turns southward. The township also contains the lower courses of Pacific Creek and Buffalo River. The surface presents very little relief. It is mostly low, rising but slightly above the level of the lake, the shores of which as well as the banks of Snake River just below the lake are marshy. Most of the northwestern part of the township in the neighborhood of the lake is covered with willows. This area, extending into the next township west, has a fine, deep soil, free from gravel, and if cleared of brush would become a fine hay meadow. There are at present two ranches upon it. The remaining country is largely open, with a few scattering groves of pine and aspen. Between the mouths of Pacific Creek and Buffalo River, on the lower hill slopes, are also groves of aspen and pine, and on the slopes of the ridge south of Buffalo River are groves of aspen.

T. 45 N., R. 115 W.—This township contains the southern portion of Jackson Lake. The land is level and raised but little above the lake. In the northeastern portion the east shore of Jackson Lake is covered with scattered groves of pine and aspen, and farther eastward with willows and grass. The eastern shores of the lake, comprised in the southern part of the township, are covered with a scattered growth of young pines. This region has been so frequently burned, down to the present time, that in the eastern part the pine seems to have difficulty in reproducing itself. In the western part, however, it is coming up very densely, so that with the thickets of young pines and the network of fallen dead timber the region is almost impassable. Here also many red firs are found which appear to have survived a succession of fires. In the northwest, at the base of Teton Range, is a small area of heavy timber.

T. 45 N., R. 116 W.—This township is comprised almost entirely in the Teton Range. In the eastern part there is included a portion of the west shores of Jackson Lake, which is timbered up to the foot of the steep mountains.

T. 45 N., R. 117 W.—This township is entirely comprised in the Teton Range, and contains almost no timber, except near the western borders, where a scattering growth begins to come in.

T. 45 N., R. 118 W.—This township is situated at the west foot of the Teton Range, where the steep slopes flatten down into Teton Basin, and contains the southern portion of the largest continuous body of timber in the reserve. The timber is young lodgepole pine, with more or less fallen dead timber, and here and there scattered through the young forests are old red firs. In the southern part of this township the timber becomes much more scattering and the pines are largely replaced by groves of aspen. A small narrow burn traverses this township up the north slopes of the spur to the region north of Lees Creek.

T. 44 N., R. 110 W.—The northeastern half of this township consists of an elevated plateau, about 11,000 feet above the sea, considerably above the limit of timber. This elevated table-land descends by a cliff 1,000 or more feet in height to a valley running northwest and southeast, in which heads Black Rock Creek on one side and a stream flowing to Wind River on the other. The summit in the valley between these two streams is Togwotee Pass, which has an elevation of 9,400 feet. Most of this valley, between 1 and 2 miles in width, is well timbered. The southwestern portion of the township is occupied by a group of hills rising from this valley to an altitude of about 11,000 feet. The slopes of these hills up to an altitude of 10,000 feet are also well timbered with pine of merchantable size, being over 2,000 feet to the acre, over an area of two and one-half sections.

T. 44 N., R. 111 W.—The northeastern part of this township is crossed by Black Rock Creek in a broad valley nearly 2 miles in width. On the northeast are the slopes of the high plateau noted in the description of T. 44 N., R. 110 W., which are here covered with a light scattering growth of conifers. The valley itself is a succession of high mountain meadows, with no trees except willows. On the southeast the land rises into irregular hills which separate the waters of Black Rock Creek from those of Gros Ventre River. These support scattering groves of conifers, which are estimated to cover from one-half to two-thirds of the surface of the western part of the township, with a number of small burns, which altogether aggregate several square miles.

T. 44 N., R. 112 W.—This township is crossed from east to west by Elkhorn Creek, on either side of which rise broken irregular hills, separating it on the north from the waters of Black Rock Creek and on the south from those of Gros Ventre River. The township is covered with groves of conifers interspersed with open areas, the timber covering from one-half to two-thirds of the surface. The trees are all young, and among them is much dead standing timber, while the ground is thickly covered with fallen trees. There are two burns of considerable importance, one about 3 miles in length by 1 mile in width lying along the north bank of Elkhorn Creek, and the other south of that stream comprising perhaps 2 square miles.

T. 44 N., R. 113 W.—The south line of this township passes over the summit of Mount Leidy. From the group of hills of which this is the principal summit the land falls northward to the canyon of Elkhorn Creek, then rises again in low hills, separating the latter from the waters of Buffalo River. The Mount Leidy group of hills is timbered with conifers up to an altitude of about 10,000 feet. These are quite heavy on the north slopes, averaging over 2,000 feet per acre over an area equivalent to four sections in this and the adjoining township on the west. North of Elkhorn Creek the high portion of the hills contains groves of conifers, covering perhaps one-half of the surface, while at the lower altitudes the timber changes into aspen groves.

T. 44 N., R. 114 W.—The southern portion of this township consists of the north slopes of high hills separating Snake and Gros Ventre rivers and descending to the valley of the former stream. These northern slopes are covered quite densely by young lodgepole pines 15 to 20 feet in height, while in the southeast the trees reach merchantable size. The lower ground at the base of these slopes contains scattered groves of aspen, while the northern portion of the township includes the immediate valley and bottom lands of Snake River and is open, with the exception of a belt immediately along Snake River covered with cottonwoods and willows.

T. 44 N., R. 115 W.—This township is practically comprised in the valley of Jackson Hole. It is crossed by Snake River, flowing southwest in a broad bottom land, which is timbered with cottonwoods and willows over an area perhaps a mile in width. On the northwest is a broad bench of gravelly soil, covered with sagebrush. On the northern edge is a small body of young pines, interspersed with areas of recent burns.

T. 44 N., R. 116 W.—The eastern third of this township is composed of the level expanse of Jackson Hole, and includes Jenny Lake and part of Leigh Lake, glacial lakes lying at the immediate foot of the Teton Range. The western two-thirds of the township are composed of high and rugged spurs of the range. The Grand Teton, the crowning summit, is in the southwest corner of the township. The eastern edge of the township is open and covered with a sparse growth of sage. The shores of Jenny Lake are timbered, the timber extending in a scattering way up the spurs and the gorge of a creek flowing into the lake. The most of the timber on Leigh Lake has been burned. The mountainous portion of the township is almost entirely devoid of timber, being too rugged and too high for a forest growth.

T. 44 N., R. 117 W.—This township is entirely comprised in the Teton Range and contains very little timber. This little is in the form of groves of pine scattered over the lower portions of the west half of the township.

T. 44 N., R. 118 W.—This township comprises the lower slopes of the Teton Range and extends into Teton Basin. The east half contains a little pine timber, mainly in scattering groves, but in the canyons of Lee and Teton creeks, especially on the south side of the latter, are small bodies of good timber, averaging over 5,000 feet to the acre. In each of these canyons there is a sawmill established, which is engaged in utilizing the timber. The western half of the township, which is comparatively level, is covered in the upper part by aspen groves and in the lower part is open and covered with grass. This area of open country, which extends south over the western half of T. 43, R. 118, is all good agricultural land and all "claimed" by persons, most of whom live on their ranches. Some of these ranches have fine berry gardens. The land is all easily irrigable from the mountain streams. The main crops are potatoes and turnips; oats and barley can also be raised. The money-making industry, however, is cattle raising, with the production of butter, etc. The soil is fine, deep, and free from gravel. The nearer the foothills, the finer and better the soil.

T. 43 N., R. 110 W.—This township comprises high hills or mountains, rising to an altitude of 10,000 feet at the heads of branches of Wind River and the Gros Ventre. One-third to one-half is timbered with groves of conifers, alternating with open parks.

T. 43 N., R. 111 W.—This township is made up of southward slopes from the divide between Black Rock Creek and Gros Ventre River and the valley of a tributary to the latter stream. The slopes are sparsely timbered with groves of conifers. The valley of the creek is open, while immediately south of it, in the southern part of the township, the country is covered with aspen groves.

T. 43 N., R. 112 W.—Across this township, from west to east, flows a branch of Gros Ventre River. North and south of it hills rise to altitudes of nearly 10,000 feet. The township is sparsely timbered, perhaps one-third of the area being covered with groves of conifers, interspersed with much dead timber. The living trees are young and small and there are numerous small burns, especially in the western part of the township.

T. 43 N., R. 113 W.—This township is drained by Gros Ventre River, which flows in a broad, open, timberless valley. Southeast of its valley are low hills with a few groves of conifers, while the northwest two-thirds of the township are composed of hills rising westward to altitudes of 9,500 feet and northward to the summit of Mount Leidy, on the north township line. These hills are sparsely covered with groves of conifers, about one-fourth of the area being wooded and the remainder parks.

T. 43 N., R. 114 W.—This township is made up of the southward slope of the hills which separate Buffalo from Gros Ventre rivers. It is sparsely covered with scattered groves of conifers, covering perhaps one-fourth of the area, the remainder being open parks.

T. 43 N., R. 115 W.—The eastern part of this township is hilly, being occupied by the eastern slopes of the spur separating Buffalo and Snake rivers from the Gros Ventre. These spurs are sparsely covered with groves of aspens and a few conifers on the lower parts. The remainder of the township consists of the open valley of Jackson Hole. Snake River flows across the northwest part of the township in a broad bottom land timbered with cottonwoods and willows. Upper Gros Ventre Butte rises from the middle of the valley upon the southwest corner of the township. This butte, rising to an altitude of 1,000 feet above the valley, is pretty well timbered at the northern end, while the greater part is covered with scattered groves of conifers. The valley is floored with good soil 3 to 5 feet deep, mostly free from gravel, and easily irrigated from Dutch Creek. All the water was taken from this creek this year by settlers.

T. 43 N., R. 116 W.—The eastern two-thirds of this township lies in Jackson Hole. It is level, and across the southeast corner flows Snake River in a broad bottom land covered with cottonwoods and willows. Back of this, on each side, is a belt of gravelly land covered with a sparse growth of sage. Succeeding this on the west is a broad belt, 2 miles in width, of fairly good timber. Some of this, over an area estimated at 2 square miles, contains over 2,000 feet per acre. The western third of the township comprises the cliffs of the eastern descent of the Teton Range. It contains very little timber, and that of poor character, consisting of the few conifers that find a footing among the rocks.

T. 43 N., R. 117 W.—This township is entirely comprised in one of the most rugged portions of the Teton Range. It is without timber, except the few scattering trees in the southeast corner and a small body in the canyon of Darby Creek in the southwest corner.

T. 43 N., R. 118 W.—This township comprises the lower slopes of the Teton Range and the eastern border of Teton Basin. Most of the area is timbered, and upon Darby Creek, in the southern part of the township, is a small but valuable body of timber, averaging over 5,000 feet per acre, for the utilization of which a sawmill has been established near the foot of the canyon. The western portion of the township is level, open, and covered with sage.

With this tier of townships the reservation, as established by the order of President Cleveland of February 27, 1897, ends. Examination was made, however, of the three tiers of townships lying farther south, and the description will be extended to include these townships.

T. 42 N., R. 110 W.—This township is composed of high hills on the northeast side of Gros Ventre River, the summits of which have altitudes exceeding 10,000 feet. The eastern half of the township is from one-half to three-fourths covered with coniferous timber, and the west half with scattered groves of aspens, covering perhaps one-third of its surface.

T. 42 N., R. 111 W.—This township is crossed from southeast to northwest by Gros Ventre River, flowing in a narrow valley, while in the northwestern part it is crossed by a tributary which enters Gros Ventre near the western boundary of the township. South of the Gros Ventre the hills which border its valley are covered with small groves of conifers, changing into aspen in the valley. North of the river the hills are similarly covered with scattered groves of conifers, changing into aspen in the northern and eastern portion of the township.

T. 42 N., R. 112 W.—This township is crossed by Gros Ventre River, flowing first southwest and then northwest. Its valley is from 1 to 2 miles in width and is covered with cottonwoods and willows. South of the river there is very little timber, except in the southwest corner, which contains scattered groves of conifers. On the northern side the land rises gradually and is almost barren of timber, the lower slopes containing a little aspen, while higher up are scattered groves of coniferous trees.

T. 42 N., R. 113 W.—This township is crossed by Gros Ventre River in a broad and almost barren valley. The hills to the north are entirely treeless, with the exception of an area of 1 or 2 square miles in the northwest corner of the township. South of the river the land rises gradually into hills, the lower slopes of which are almost treeless, but higher up there is a dense growth of coniferous trees, which, over an area of two sections in this township, average 2,000 feet or more per acre. The summit of the hills is treeless.

T. 42 N., R. 114 W.—This township also is crossed by Gros Ventre River, flowing a little north of east in a rather narrow valley. North of the stream there is practically no timber. South the hills rise abruptly to a high summit of 11,000 feet. These slopes are very well timbered. Over an area of four sections it is estimated that the timber exceeds 2,000 feet per acre, although some of this has been recently burned.

T. 42 N., R. 115 W.—This is crossed by the Gros Ventre, flowing somewhat south of west in a valley which at first is narrow and then opens out into Jackson Hole. The southeastern part of this township is mountainous, forming the western end of the spur separating Gros Ventre River from Little Gros Ventre Creek. The higher portions of these hills and their northern slopes contain some conifers. On the lower slopes are groves of aspen. The level portions of the township, those within Jackson Hole, are mainly covered with sage and grass.

T. 42 N., R. 116 W.—This township is comprised entirely in the valley of Jackson Hole. On the south line of the township the Gros Ventre joins the Snake. The surface of the township is level, except for river benches. The rivers are bordered by broad belts of cottonwood and willows. The benches are in the main covered with sage and grass. A few conifers are found in the northwest corner of the township.

T. 42 N., R. 117 W.—This township is mostly comprised in the Teton Range, the southeast corner only being within Jackson Hole. This portion is covered with sage and grass, and the streams coming down from the mountains have formed sloughs and meadows from which considerable hay is cut. The mountains are almost entirely treeless, with the exception of a few small groves of conifers on the lower slopes.

T. 42 N., R. 118 W.—This township is almost entirely comprised in the Teton Range, and contains very little timber except in the canyons of Darby and Fox creeks. The former stream especially has a fairly good body of timber on it. Aside from these two canyons the only timber is found in a few groves scattered over the lower slopes.

T. 41 N., R. 110 W.—This township is traversed by the upper waters of Gros Ventre River, flowing northeastward across it in a narrow valley. The hills upon each side are fairly well covered with conifers.

T. 41 N., R. 111 W.—This township is traversed by branches of Gros Ventre River, between which is a high, rolling country. It contains very little timber, large areas having been recently burned.

T. 41 N., R. 112 W.—This township is drained by a tributary flowing north across it into Gros Ventre River. The land rises gently from the valley of this creek on the eastward, and is almost treeless. West of this creek are scattered groves of conifers, covering, perhaps, one-half the area.

T. 41 N., R. 113 W.—This township is traversed from south to north by a branch of Gros Ventre River. From its valley the land rises steeply to high, plateau-like summits with an altitude of 10,000 to 11,000 feet. The township contains very little timber, neither the slopes nor the summits of these plateaus being forested.

T. 41 N., R. 114 W.—This township is drained by Little Gros Ventre Creek. From its narrow, canyon-like valley the land rises steeply several thousand feet to the summit of high plateaus between 10,000 and 11,000 feet in altitude. The canyon walls of this stream are fairly well timbered. Elsewhere timber occurs only in small groves and bunches, while the summit of the plateau is everywhere bare.

T. 41 N., R. 115 W.—This township is made up in the main of extremely broken country, draining into Gros Ventre River. On Pollock Creek, one of the branches, is a considerable body of good timber. Elsewhere timber occurs only in patches of small area and consists entirely of conifers.

T. 41 N., R. 116 W.—This township lies in the main within Jackson Hole and contains the lower Gros Ventre Buttes and the western end of the mountain mass lying south of Little Gros Ventre Creek. Besides a few scattered groves of conifers, the township contains no timber, except on the western end of the upper Gros Ventre Buttes, lying in the northwest corner of the township. This is well timbered with conifers.

T. 41 N., R. 117 W.—At least half of this township lies within Jackson Hole, and is traversed by Snake River from north to south and by Fighting Bear Creek. That part of the level valley lying between the river and Fighting Bear Creek contains scattered groves of lodgepole pine and Engelmann fir, with open parks and a little cottonwood. The western part of the township is in the Teton Range and contains several patches of timber of some importance. One of these, 3 or 4 miles square, lies on the mountain spur. Another is on the south wall of East Pass Creek, where there is a sawmill engaged in cutting lumber for local consumption.

T. 41 N., R. 118 W.—This township is comprised within the range, and its surface is extremely rugged. On the south canyon wall of Trail Creek, which flows westward from the pass, is a considerable body of good timber, and there are a few small patches scattered about elsewhere on the mountain spurs.

T. 40 N., R. 110 W.—This township comprises high rolling country about the heads of Gros Ventre River. This area is perhaps two-thirds covered by young pines.

T. 40 N., R. 111 W.—The surface of the country is entirely similar to that of the township last described, being high and rolling, but there is scarcely any timber on it.

T. 40 N., R. 112 W.—This township also lies high, being at the heads of branches of Gros Ventre River, and consists of a rather undulating country. It is estimated that half its area is covered with groves of pine.

T. 40 N., R. 113 W.—This township is intersected by the gorges of streams flowing into Gros Ventre River. The country is high and broken and contains no timber.

T. 40 N., R. 114 W.—This township is very similar to the one last described, being high, broken, and timberless.

T. 40 N., R. 115 W.—This township comprises the summit of the hills from which flow the waters of Little Gros Ventre Creek. It is high and broken and the only timber contained on it is in a few scattered groves.

T. 40 N., R. 116 W.—The eastern part of this township comprises the lower slopes of the hills in which Little Gros Ventre River collects its waters. These hills are almost timberless, the forest consisting of scattered groves of trees. The western half is in the valley of Jackson Hole. It is a level country, covered with sage and brush.

T. 40 N., R. 117 W.—The northeastern portion of this township is in Jackson Hole, the level portion being sharply outlined by Snake River, which flows southeast across the corner of the township, closely hugging the foot of the Teton Mountains. The western part of the township, including fully three-fourths of it, is included within the range, the northeast slopes of which are fairly well timbered.

T. 40 N., R. 118 W.—This township is entirely comprised in the Teton Range and, owing to its high and rugged character, contains no timber whatever.

SAWMILLS.

The sawmills operating in this reserve and its vicinity are few and of small capacity. One that is off the reserve is situated east of the Teton Pass. It is now in operation. The market must mainly be the settlers of Jackson Hole, for the steep road over the pass will prevent any heavy load being hauled over it.

Darby Creek.—This is a new mill which has just gone into operation. In addition to a sawmill, there is also a mill for "finishing" lumber. To this mill the inhabitants of Teton Basin look for lumber. There is said to be 1,000,000 feet above it, and the estimate does not appear excessive. All the mills saw mainly *Picea engelmanni*, but also cull out the large *Pinus murrayana*, and a red fir, if near, is of course also cut. The logs are 20 to 30 feet long, but the lumber has many knots. The logs for this mill will be cut from the low, damp ground above.

Teton Creek.—This is an old mill, having been in operation, it is said, nine years. The mill is supposed is be nearly worn out, and it seems certain that there is no more timber of any account to be sawed. It is sawing now on an "order." The quantity of timber sawed is not known, but is probably not a large amount, as little is required to supply the needs of a community that builds log houses and pole fences.

Lees Creek.—This mill has not cut very much and has been ordered out by the Government. It has permission to saw the logs on hand, about 75, and have piles of lumber made from about the same number. There does not seem to be so much lumber to be cut as above the Darby Creek mill. All the mills saw mainly *Picea engelmanni.*

ROADS AND TRAILS.

It seems hardly necessary to discuss fully the practicability of transporting lumber in a country that has so little that is merchantable. The distance from a market is so great and the timber is so poor that it will probably never be exported, even if a railway should be built through the valley. There will, however, be a small home demand. There is a road of easy grades up the Snake to the Yellowstone Park, which would also be good to Victor and Teton Basin but for the exceedingly steep grades about Teton Pass. The road from the United States military station by Grassy Lakes to Fall River has very easy grades so far as I have seen it, and is said to be excellent its whole length. Logs could be easily floated down Buffalo Creek and Gros Ventre, both large streams, and roads can easily be constructed up their valleys well into the mountains.

GAME.

Great numbers of elk come down from Yellowstone Park and feed in the high mountains during the summer. In the winter, when they are driven by cold and deep snows to seek their food at lower elevations, their number is much increased. The settlements of the Teton Basin and regions west of the mountains have very much restricted their winter feeding grounds, and the settlement of Jackson Hole increases the difficulty of finding winter feed. It is said that a thousand died from starvation in Jackson Hole last winter.

RANCHES.

There were within the reserve at the time of its examination about 40 ranches, 19 of which were on the eastern edge of the Teton Basin and 21 in Jackson Hole. These are in the main small cattle ranches on which there is practically no cultivation of the soil. The cattle range during the summer, and wild hay is cut for their winter subsistence. Jackson Hole and the neighboring mountains being a resort for fishermen and sportsmen, much of the business of the settlers in this valley consists in supplying these tourists with outfits and supplies.

Owing to the hostility of the present residents of Jackson Hole and the Teton Basin, all of whom are cattlemen, there are no sheep within the reserve. The number of cattle and horses in Jackson Hole is very small, being limited by the amount of forage which can be cut and stored for winter use. At present they range in the valley, to all parts of which their range does not yet extend.

YELLOWSTONE PARK FOREST RESERVE.

(Southern Part.)

From notes by Dr. T. S. BRANDEGEE.

LIMITS AND TOPOGRAPHY.

This reserve lies east and south of Yellowstone Park. The portion south of the park, lying between its south boundary and the north boundary of the Teton Reserve, which is the parallel of 44° north latitude, and between the 110th meridian and the west boundary of Wyoming, was examined by Dr. T. S. Brandegee, and the following report has been prepared from notes furnished by him.

This portion of the Yellowstone Park Reserve has a breadth from north to south of approximately 10 miles, and its length east and west is 51 miles. It comprises an area of 510 square miles, or 326,400 acres. The eastern part is drained northward by Upper Yellowstone River, while the greater portion of it is drained southward by Snake River and its tributaries.

The elevation of the region is great, ranging from 7,000 to over 10,000 feet, with an average elevation probably between 8,000 and 9,000 feet.

Upper Yellowstone River enters near the southeast corner and flows northwestward across the reserve in a marshy valley about a mile in width. East of the river the land rises to a high plateau 9,000 to 10,000 feet in altitude. West of it the country between the river and Atlantic Creek, which heads in Two Ocean Pass, is plateau-like in character, with summits exceeding 10,000 feet in altitude, and is much dissected by streams. The Continental Divide, separating the Upper Yellowstone from the drainage of Snake River, has a general altitude of about 10,000 feet, but is broken by several passes at much lower altitudes. The well-known Two Ocean Pass, in which head Atlantic and Pacific creeks, which have water communication, has an elevation of 8,200 feet. A pass separating Mink and Falcon creeks is slightly lower, its height being 8,100 feet.

West of the divide and east of Snake River the country is mountainous, the summits ranging from 9,000 to 10,000 feet. There is little system to this country and the streams pursue circuitous courses. Snake River flows across the reserve, in a course a little west of south, in a marshy valley about a mile in width. The country west of Snake River is the northern extension of the Teton Range. It is here much depressed, presenting little of the rugged character which prevails farther south. On the southern border of the reserve these mountains reach an altitude of 9,000 feet, from which they descend to a depression at the north boundary of the reserve, where there is a broad pass, connecting the valley of Snake River with Falls River Basin, and having at the divide an altitude of 7,000 feet. Falls River Basin, which occupies the western portion of the reserve, is low, level, and very marshy, with an altitude slightly less than 7,000 feet.

This region, owing to its great altitude, has an ample rainfall and a severe climate. It is probable that no part of it is suitable for agriculture. The question of agricultural lands in this reserve may, therefore, be dismissed on account of the climate.

FORESTS.

As a whole, this portion of the Yellowstone Park Reserve has much more forest on it than has the Teton Reserve, lying immediately south. This fact is largely due to the somewhat greater altitude of the region, and perhaps also to the fact that fires have not been quite so frequent or so destructive. There is no part of the reserve, except the limited areas which are above timber line, on which forests will not grow freely if protected from fires, and the fact that it is not entirely clothed with dense forests is probably due entirely to the former prevalence of this destructive agent.

The forests of this region are principally made up of *Pinus murrayana*, or lodgepole pine. Besides this species, groves of quaking aspen are scattered in many localities, especially where fires have raged in recent years. These are especially abundant west of the Teton Range. In certain localities *Pinus flexilis* is found abundantly, especially about Huckleberry Peak, on the summit of the Continental Divide, and generally on exposed ridges. There is very little *Picea engelmanni* (Engelmann spruce) in the reserve. It is found occasionally along the streams, and some is found about the slopes of the Continental Divide. Red fir is scattered about quite generally through the forests in isolated specimens. *Abies lasiocarpa* is nowhere abundant, but is generally found on the higher elevations and along the streams. In brief, the species are the same as found in the Teton Reserve, and their distribution is similar. Indeed, the general notes relating to the Teton Reserve will be found to apply very closely to this one.

This reserve was mapped by the United States Geological Survey on a scale of 1:125,000, the relief being expressed by contours with intervals of 100 feet. Upon this map (Pl. XLIII) the distribution of timber is represented, its density being shown by shades of blue, the lightest shade representing wooded areas which are not regarded as containing merchantable timber, the next darker shade representing forests containing merchantable timber with an average of less than 2,000 feet B. M. to the acre, a third shade representing areas containing 2,000 to 5,000 feet per acre, while a fourth shade represents those containing more than 5,000 feet per acre. The red patches represent areas recently burned, upon which the forest has not yet made a start. It must not be understood that these red areas represent all those which show evidence of fires, since a large proportion of the area has been burned within a generation, and little of it has escaped fires at some time in the past.

Since this reserve has not been subdivided, it will be necessary, in the detailed description of it, to refer to natural landmarks rather than to township lines. This description will be given by commencing at the east and going westward.

The valley of the Upper Yellowstone is, in the main, open or covered with willow brush. The lower slopes of the plateau to the east are pretty well timbered, especially on the isolated summit known as Hawks Rest and on the slopes of the valley of Thorofare Creek. The higher slopes and the summit of the plateau are entirely bare.

The northern end of the plateau separating Atlantic Creek from Yellowstone River is heavily timbered up to the summit. Following up the slopes of this plateau southward along the west wall of the valley of the Upper Yellowstone, the timber diminishes in amount and becomes reduced to scattered groves, which extend over the summit of the plateau, covering, perhaps, one-third its area. On the side toward Atlantic Creek this condition of things continues, but the proportion of land covered by the timber remains about the same. The valley of Atlantic Creek and the slopes of the plateaus rising from it on the west are covered with scattering groves of timber, one-fourth to one-half the land being covered. The plateau slopes rising from the valley of Falcon Creek on both sides are heavily timbered, but about the head of the creek the timber becomes scattering. The summit of the Continental Divide, from the north boundary of the reserve to Two Ocean Pass, is either bare or covered with scattered groves alternating with open parks.

West of the divide, the country drained by the headwaters of main Snake River and Fox Creek is covered with scattered groves of trees. Farther south, between Pacific and Mink creeks, on the west slope of the divide, is found one of the heaviest bodies of timber in the reserve. It covers nearly 20 square miles, and is almost a solid forest, averaging over 2,000 feet B. M. to the acre. The central portion is the most dense, and there, for an area estimated at a square mile or more, the forests average more than 5,000 feet per acre. South of Pacific Creek is another considerable body of timber, averaging more than 2,000 feet per acre, although near the creek fire has destroyed some portions of it.

The east slopes of Big Game Ridge contain very little timber, distributed in groves. The west slope of the ridge is quite similar in timber distribution, except near its southern end. Here is another heavy body, covering most of the country between Gravel Creek and the summit of the ridge, an area 4 miles in length by 1 mile or more in breadth.

The country bordering on Harebell, Wolverine, and Coulter creeks contains scattered groves, the timber covering, perhaps, half the area. The timber becomes more dense farther down the course of main Coulter Creek. Southward, beyond the divide, along the streams flowing southward to Snake, there is very little timber. This region, extending on the north to the higher slopes of the hills, and eastward as far as Pinon Peak and the valley of Gravel Creek, has apparently been burned not long ago, and some portions of it, as indicated by the red patches, very recently. On this area there are no large trees, but here and there are scattered groves alternating with barren patches. This incipient forest is composed mainly of firs and *Abies lasiocarpa.* It contains, also, large areas of dead standing and fallen timber, the remains of the fires.

The large area of timber represented as lying just east of Snake River, and extending eastward north and south of Huckleberry Mountain, consists mainly of dense groves of young lodgepole pines, interspersed here and there with dead standing timber, and on the higher elevations with *Pinus flexilis.*

West of Snake River the triangular area north of the stream leading up toward Grassy Lakes is covered with a scattering growth of pines of good size, suitable for lumber purposes. On the south side of this creek, extending across the divide and down the west side of Teton Range, is a large area of good timber, grading above the 2,000-foot limit over most of the area, while in two localities, about Grassy Lakes and on the west side of the divide, it grades above 5,000 feet. Here and there throughout this body of timber are dead pines, standing and fallen, giving evidence of fires in the past. A similar, but smaller, body of timber is seen on the south side of Berry Creek. On the higher summit of Teton Range the timber is either scattering or entirely lacking.

SETTLEMENT.

The only settlement within this part of the reserve is a station of United States troops on Snake River. There are no sawmills within it, and it is unlikely that there will be any demand for timber from it in the immediate future, as the nearest settlements of magnitude, those in Teton Hole and in Wind River Valley, may be more economically supplied from other sources.

PRIEST RIVER FOREST RESERVE.

By JOHN B. LEIBERG.

INTRODUCTION.

The data on which this report is based were in part obtained during several preliminary trips along the eastern and southern portions of the reserve during the months of May and June, and in part during the month of July and the first half of August, 1897, when the reserve was traversed from north to south along three different routes, with frequent crossings from east to west.

In a region so difficult of traverse as the Priest River Reserve, and without areal surveys to guide in determining superficial contents of the several tracts, it is not to be expected that every small subdivision has been examined in detail in the brief time allotted to the work, nor that the average estimate is absolutely exact. A general summary of the conditions is all that has been attempted. It is believed, however, that all estimates are conservative and approximately correct. An absolutely accurate account can not be had until the entire area shall have been surveyed and subdivided, and each quarter section successively examined—a labor that, even on the comparatively small area embraced within the limits of the reserve, would require the work of several seasons.

TOPOGRAPHY.

The Priest River Forest Reserve as at present delimited consists of the drainage basin of Priest River, a stream having its ultimate head at or slightly beyond the forty-ninth parallel and flowing in a southerly direction to a junction with the Pend Oreille River, together with a small area in the immediate valley of the Pend Oreille. It is situated mainly within the borders of the State of Idaho, in Kootenai County, a small portion of the western area extending beyond into the State of Washington.

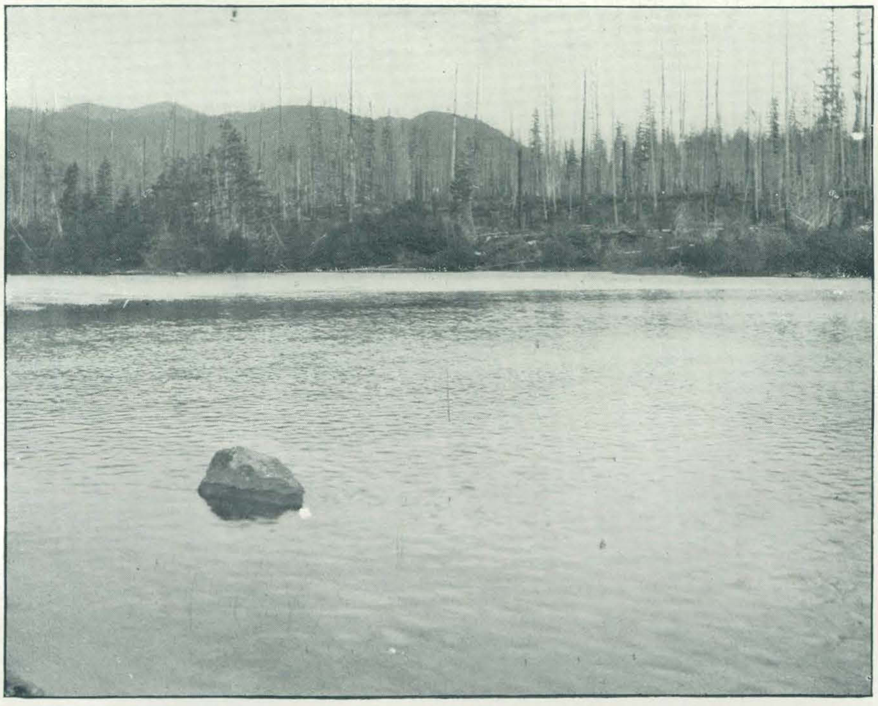
It is essentially a mountain region, the flat or approximately level tracts probably not forming more than 12 to 14 per cent of the whole. In elevation it varies from 2,000 to about 8,000 feet, the mean being about 3,800 feet above sea level.

The long diameter of the basin is from south to north, being rather more than 55 miles; the short one, from east to west, has an average width of about 20 miles. Its position presents a broad opening toward the south and southwest, an ideal one in this region to insure a heavy yearly precipitation over the entire area, and as a result a dense forest growth. The region is limited on the east and west by two north-south mountain ranges, which converge at their northern extremities and form the head of the basin, but recede from each other toward the south. The eastern range is here named the Priest River Range; the western one the Pend Oreille Range. From each of these primary ranges secondaries project far into the basin, and by repeated subdivision nearly fill it with a rugged mass of spurs and ridges.

The Priest River Range is the loftier. Its central regions are the most elevated; the sinuous crest line of the backbone maintains an altitude between 5,000 and 6,000 feet for the greater portion of its length, rising in some localities to about 8,000 feet. Its rock formation consists of hard but much fissured granites and syenites, with occasional areas of slates and gneisses along the southern extremity. It has been deeply sculptured and eroded by glacial action, creating deep canyons and wearing the crest in many localities to a mere narrow margin between great precipices on either side.

The Pend Oreille Range, which incloses the basin on the west, forms the divide between Pend Oreille and Priest rivers. It is much less rugged than the Priest River Range and has a less elevated crest line, rarely rising above 6,000 feet. It is mostly composed of schistose rocks, traversed more or less by granitic extensions from the eastern areas. Owing to the softer materials composing its rocks, the lines of erosion are more rounded, presenting longer slopes that incline toward the central depression with angles much less acute than is the case with the Priest River Range. The troughs between the lateral ridges are broader, less canyonlike, forming flat, often swampy valleys with lake-like expansions that occasionally hold small ponds. The diversity in rock formation, with consequent unequal sculpturing and erosion, divides the basin into two areas with very dissimilar topographical features and of different degrees of economic importance. The present shape of the basin is largely due to the pressure and wear of a large glacier that once filled the basin. It appears to have originated in the high eastern range, moving thence toward the west, and eventually sliding southward into the Pend Oreille Valley. The hard granitic areas on the east were cut into steep spurs and narrow, deep canyons, while the softer schistose ridges on the west, offering less resistance, were extensively ground down and the depressions between them filled with glacial débris, forming broad flats and valleys. Upon the permanent recession of the glacier a lake occupied a large portion of the basin, submerging the low areas, depositing a lacustrine sediment, and thereby further smoothing out the surface of the valleys. The lake has gradually dwindled in size, due in part, perhaps, to the removal of a terminal moraine at the south end of the basin, in part, certainly, to the channel excavated by Priest River to its junction with the Pend Oreille

A. A PORTION OF THE PRIEST RIVER DIVIDE. LOOKING WEST.



B. PRIEST RIVER AT ITS OUTLET FROM LOWER PRIEST LAKE.

through the mass of glacial débris along its course, and in part, not unlikely, to a continued uplift of the rocks forming the basin. Since the disappearance of the glacier and after the rapid drainage began, the valleys have been more or less excavated by their shifting drainage channels, causing the terraced formation which we now find.

The drainage system of the basin consists of Priest River, the principal stream, with several large forks and numerous smaller tributaries as feeders. The two upper main forks of the river are about 10 miles in length. They head partly in the angle of convergence formed by the two great north-south divides that inclose the basin and partly in the northern portion of the west range. The western of these forks is named Gold Creek; the eastern is considered as the upper portion of Priest River. About 3 miles below the junction of the two forks the stream enters Upper Priest Lake, a shallow sheet of water about 2 miles long and 1 mile wide. At its southern end it is connected with Lower Priest Lake through a somewhat tortuous channel, named the Thorofare, about 2 miles long and varying in width from 75 to 120 feet. A sluggish current runs through this channel, which has a depth of 2½ to 12 feet at medium stage of water. Lower Priest Lake is about 18 miles in length and from one-half to 5 miles in width. Its position is nearly on the dividing line between the two rock formations of the basin. The eastern shore is bold and rocky, rising rapidly by steep encarpments and spurs to the summit of the main divide. The spurs and ridges that form the western shore are mostly low and are broken at frequent intervals by broad valley openings and swampy areas stretching westward. The lake serves as a central reservoir and receives about 65 per cent of the entire drainage of the basin. There are no data obtainable as to its depth. The deepest portion is evidently east of the center line. Numerous shallow gravel, sand, and bowlder bars project far out from the western side, especially at the outlet of the various creeks. The lake contains six islands. Three of these are merely the projecting tips of rock spurs still submerged. The others are larger, but none are of any economic importance. The outlet of the lake is by Priest River, which leaves it at the southwest corner through a channel about 400 feet wide and averaging about 3 feet in depth at medium stage of water. The course of the river to its junction with the Pend Oreille is generally southward, with a length of about 32 miles. A number of tributaries enter along the way, the most important being the upper and lower West Forks from the west and the East Fork from the east.

The current is swift, especially in the lower one-third of its length, where there exists a series of rapids extending a distance of 7 miles. These rapids are mainly due to huge bowlders dropped into the bed of the river by its excavation through the moraine material. The total fall in the river from the outlet in the lower lake to its junction with the Pend Oreille is about 600 feet. At the point of junction, or about one-third of a mile above, it is nearly 300 feet wide, with a depth in mid-channel of about 7 feet at its summer stage and a current of between 2 and 3 miles an hour. The valley of Upper Priest River is a mere narrow canyon for about 10 miles of its length, as is that of its principal upper fork, Gold Creek. Below the junction of this fork to the head of the upper lake the river flows through a low swampy valley about three-fourths of a mile wide.

The valley below the lower lake has a width varying from about 2 to 4 miles. Low isolated ridges rise here and there, their bases buried in the mass of glacial detritus that has filled up the inequalities and approximately leveled the area that now constitutes the valley. Through this mass of transported material the stream has cut its way, excavating a channel that at the present time varies from 20 to 150 feet in depth from the water line to the top of the inclosing banks.

WATER SUPPLY.

The reserve is situated within one of the zones of heavy precipitation in northern Idaho. Just how great the annual precipitation is we do not know, no data being obtainable in regard to it, but that it is exceptionally heavy is proved by the enormous development of the arborescent flora of the region. It is probable, however, that it lies between 50 and 60 inches for areas under 3,500 feet elevation above sea level, and from 60 to 90 inches for those above that altitude. The depth of snow on the ridges at 6,500 to 7,000 feet elevation varies from 12 to 20 feet, as indicated by marks on standing trees. Considering the extremely wet nature of northern Idaho snows, 80 to 90 inches is probably rather under than above the actual annual precipitation at these heights. The water of precipitation is discharged slowly into the streams. The granitic rocks of the eastern range are much broken and fissured, permitting the water to sink freely and emerge as springs at lower elevations. There is a permanent snow line on the northern slopes in the central sections of the range, but the amount of snow retained through the summer is not large enough to affect materially the water supply. Many of the streams that head in the range expand into semicircular basins near their heads. Some of these basins contain small ponds; others are partially filled with great masses of slidden rock which retain large quantities of water. Owing, however, to the precipitous nature of the range, and the short distance between the summit and the lake basin, the drainage is too rapid on the whole, and but one stream of considerable size, the East Fork, heads in the range. The streams that enter the lake and river from the west are longer and carry a greater volume of water. Their heads are at greater distances from their points of discharge, and, flowing through valleys with but little slope, their currents are rather sluggish. Many of them head in large marshy or springy tracts, and in their course are frequently interrupted by large timbered flats or low swampy meadows or sphagnous bogs. These flats and bogs are important conservators and regulators

PRIEST RIVER NEAR ITS JUNCTION WITH THE PEND OREILLE.

of the water supply of the basin. The flow of water in the basin is apparently not subject to very violent fluctuations. The difference between high and low water in the lake is said to be but 5 feet. Whether the present condition of the forest in the region affects the drainage as compared with the flow of water in the past, when different conditions existed, can not be learned, as the observations extend back only seven years. I am of opinion, however, that the spring freshets are greater than formerly and the summer stage of water less.

The water in the streams and lakes is not utilized in any way at the present time. The existing agricultural interests are small, and irrigation has not been found necessary for their maintenance, nor are there within the reserve any industrial enterprises that require water power. All the larger streams that enter the lake and river from the east have volume and fall sufficient to furnish great quantities of power, a few from the west could be utilized in the same way, and the main Priest River, especially below the rapids, is capable of supplying enough for all enterprises likely to be located within the reserve for generations to come. There appears, so far, to be but one location for purposes of power on any of the streams. This is at Blue Creek, about one-third mile above its junction with Priest River. The creek here runs over a ledge of outcropping rocks, forming a series of falls and rapids with a total descent of between 30 and 40 feet.

SOIL.

The soil of the basin varies considerably with location and elevation. In the eastern half of the basin, where the underlying rock is largely composed of hard quartzose granites, the soil is very siliceous. The softer schistose formations of the western half have yielded a soil with less silica and more magnesia and alumina. The soil on the summit of the main ridges, spurs, and upper slopes is a coarse gravel or sand thinly mixed with mold derived from ages of decaying forest growth, usually but a few inches in depth and resting on a substratum of still coarser fragments of rock or bowlders. The lower slopes and bottoms of the canyons heading in the eastern range are covered with masses of bowlders and slidden rock fragments, more or less cemented together by stiff clays and overlain by thick deposits of black mold and humus, in part accumulations washed down from the heights above. The low-lying broader and less sloping valleys on the west, together with the main Priest River Valley, have a subsoil wholly made up of glacial detritus, consisting in some localities of stiff, impermeable, gray, or extremely ferruginous clays, but mostly composed of fine or coarse gravel. The depth of this subsoil is unknown. It is commonly topped off by several feet of lacustrine silt, on which rests mold and humus of varying thickness, from 3 or 4 inches to 15 or 20 inches. The marshy flats or meadows occurring in the western half of the reserve are often the result of beaver dams, constructed ages ago when the animals were plentiful and worked comparatively undisturbed. Owing to the more rapid growth and decay of vegetation on such tracts, there is a greater accumulation of mold than elsewhere, and it is also more fertile. The fertility of the soil resides largely in the superficial layer of mold and humus. When stripped of this the underlying silt deposit comes into view. While not so siliceous as the soils of the granitic half of the reserve, it contains too much silica to be classed as a prime soil for agricultural purposes. One chief drawback is its failure to retain moisture, losing it rapidly both by evaporation and by percolation. When, therefore, denuded both of its forest covering and the top layer of humus, the soil is apt to become quite sterile, owing to aridity. The soils on the small portion of the reserve that abuts on Pend Oreille River are mostly similar to those of the Priest River Basin proper. Exceptions are found on lands periodically overflowed, which are covered by a slimy subalkaline mud deposited from the waters of the river.

FOREST CONDITIONS.

The Priest River Basin is essentially a forest-covered region. There are but few tracts within its boundaries that do not now, or did not a few years ago, support a dense, magnificent forest. The areas destitute of forest from natural causes are the low marshy expanses and sphagnous bogs along certain of the water courses, and rocky crests and slides of the main divides and of their higher laterals. Of the entire land area within the reserve, I estimate that about 3.5 per cent is naturally devoid of forest. Assuming that lakes and streams of the reserve cover in the aggregate about 30,000 acres, and that the entire reserve consists of 650,000 acres, we have a trifle more than 7.9 per cent deforested through the operation of natural causes. It would be possible to reclaim about 2.5 per cent of this by sylvicultural means, leaving but 5.4 per cent permanently timberless. The distribution of the timberless areas is nearly equal for each of the two divisions of the reserve, but their respective situations are diametrically opposite, for while the timberless tracts that exist in the western half are mainly grassy marshes at low elevations, those of the eastern half are regions of bare rocky expanses along the upper slopes of the divides.

The forest growth on the reserve is composed of sixteen species of trees that are always arborescent, and seven that are either small trees or shrubs, depending on soil and altitude. (See tables, p. 244.) Eleven of the trees are gymnosperms, or cone bearers; ten are evergreens; one, the larch, deciduous leaved. Five are angiosperms; three belonging to the willow and two to the birch family. Nine belong to the species commonly utilized as lumber trees, seven being conifers, two cottonwoods. Ninety-nine per cent of the lumber trees are comprised in five species, namely, western white pine, western larch, hemlock-spruce, cedar, and yellow pine. Of these, the white pine and tamarack (the larch) form about 91 per cent of the total. The distribution of

A FOREST IN THE WHITE-PINE ZONE, PRIEST RIVER FOREST RESERVE.

the arborescent flora lies within three of the western forest zones, the zones (1) of the yellow pine, (2) of the white pine, and (3) of the subalpine fir.

The zone of the subalpine fir comprises, in general, the ridges and slopes above 4,800 feet elevation. It follows, however, many of the smaller streams and the northern slopes of the ridges to lower altitudes, in such cases mingling with the white-pine zone. It covers about 10 per cent of the reserve area, or about 60,000 acres in the aggregate. The best development of the zone occurs on the summits, slopes, and higher portions of the canyons of the eastern or Priest River Range. It is found likewise on many of the spurs that extend into the basin from both the eastern and the western divide. It is less prevalent on the summits and slopes of the Pend Oreille divide, and has there a greater admixture of species from the zone below. Of the total area included within the zone, 7 per cent, or about 42,000 acres, is situated in the eastern half of the reserve, and 3 per cent, or about 18,000 acres, in the western half. The difference in development of the zone between the eastern and western portions of the basin is owing, in part, to the greater height of the Priest River Range, with the consequent increase in precipitation and lowering of the mean annual temperature, and, in part, to the difference in rock formation. The granites of the eastern range, with their extensive fissuring and no definite cleavage, hold precipitation far better than the schistose rocks of the western range, which are either water-tight or else afford a more or less rapid drainage along their cleavage, depending on their angle of inclination. The characteristic trees of the zone are the subalpine fir and white-bark pine. (See tables, p. 244.) According to the direction of slope exposure, there also occur the Engelmann spruce, the red fir, the lodgepole pine, the western white pine, and the tamarack, together with the American aspen. About 98 per cent of the forest growth of the zone is composed of two species, the white-bark pine and the subalpine fir, about 28 per cent of the former and 70 per cent of the latter. (For range in sizes see table, p. 246.) This zone possesses but little economic importance. The trees that form the bulk of it are not commonly utilized, and its considerable altitudes make it inaccessible to the lumberman.

The white-pine zone is the predominant one in the reserve. It lies principally between altitudes of 2,400 and 4,800 feet above sea level, and reaches its greatest development between elevations of 2,800 and 3,500 feet. Its area is about 80 per cent of the forested portion of the reserve, or about 480,000 acres, including such tracts as are now in a state of reforestation and covered with pure, or nearly pure, growths of lodgepole pine. The principal species of trees growing within the zone are the western white pine, tamarack, cedar, Engelmann spruce, Merten hemlock, and white fir. Mixed with them are scattered individuals of the red fir, cottonwoods, birches, and semiarborescent willows. The western white pine and the tamarack are the chief components of the zone, forming about 77 per cent of the entire growth, western white pine constituting about 42 per cent and tamarack about 35 per cent. (See tables, p. 246.) The heaviest growth of the zone occurs on the level areas bordering the principal streams. The white pine is therefore more abundant in the western half of the reserve and along the Lower Priest River than elsewhere. Some of the stream bottoms in the southeast corner of the reserve, opening into the Pend Oreille Valley, have also considerable bodies of it. The region of the white pine is the most important in the reserve from an economic standpoint. It contains by far the largest quantity of commercial timber that exists on any of the growing areas.

This zone is generally easy of access, and, if the natural conditions of soil and humus are not disturbed, is capable of maintaining and of rapidly producing a heavy forest growth. The zone is remarkable for the prodigious development of its two principal components, the white pine and the tamarack, surpassing in density any other area of similar composition in the West. Two stages of growth occur in the commercially valuable bodies of this timber. They are the "old growth" and the "second growth." The former ranges in age from 250 to 400 years, the latter from 100 to 250. The old growth is found as small, scattered groves throughout the reserve, but in a large block only in the main Priest River Valley below its junction with the East Fork. It forms here a tolerably compact body of about 2,500 acres, with extensions up several of the adjacent canyons on the east amounting to about 1,000 acres more. The total area of the old growth is approximately 10,000 acres. The second growth was well developed in all portions of the reserve up to within the last thirty years. At the present time the heaviest bodies exist in the valleys of the Upper and Lower West Forks, especially in the latter. (For relative sizes of trees, see tables, p. 247.) The zone is not so well defined as that of the subalpine fir. Along its upper limits it contains more or less subalpine elements, and at its lower limits trees from the zone of the yellow pine. The only species of tree within the reserve not found in the white-pine zone is the white-bark pine.

The zone of the yellow pine occupies mostly a lower position than that of the white pine. It is not generally possible, however, to draw a well-defined line of demarcation between the upper limits of one and the lower limits of the other. The two zones overlap constantly, depending largely on soil and moisture conditions. The main components of the zone are the yellow pine, red fir, and white fir, in about the following proportions: Yellow pine, 10 per cent; red fir, 70 per cent; white fir, 15 per cent. (See table, p. 246.) The altitudinal limit of the yellow pine as a commercially valuable tree on the reserve is under 3,500 feet above sea level, while the red fir readily ascends to elevations of 4,500 feet on the slopes fronting on the south, west, and east. The area covered by this zone is about 10 per cent of the forested portions of the reserve, or about 60,000 acres. It is therefore

A FOREST OF LODGEPOLE PINE 60 TO 100 YEARS OLD, PRIEST RIVER FOREST RESERVE.

equal to the area of the subalpine zone, and, as a whole, is more equally distributed between the east and west halves, about 4.7 per cent being in the former and 5.3 per cent in the latter division of the reserve. There is, however, a marked difference in the distribution of the yellow pine and the red fir, the pine predominating in the eastern half and the red fir in the western. The commercially valuable areas of yellow pine are much scattered. There are small tracts of it along the eastern shore of Lower Priest Lake, and some scattered growths facing the south and west on the rockier spurs that come into the main valley from the east below the lake. The largest bodies of it are found in the southeast quarter of the reserve, but are not continuous over any considerable area, as most of the canyons which radiate from the main valleys carry the white-pine zone in their bottoms. The tracts which are covered with commercially valuable hemlock-spruce occur all over the reserve below the upper altitudinal limits of the zone to which they belong. The largest continuous growth of the species occurs, or rather occurred, along the summits and slopes of the southern portion of the Pend Oreille divide, before the forest fires had done their work in that locality. The yellow pine is, on the whole, more difficult of access than the white pine, due to its habitat upon the rocky slopes and benches.

ASPECT OF THE FOREST.

The appearances of the growing forest are different for each of the zones, and several varying aspects occur in each subdivision; but as like conditions have produced them, they are quite uniform throughout the reserve. There are no forests of pure growth on the reserve, the nearest being the forests of the subalpine zone, and the tracts covered with lodgepole pine, within the limits of the white-pine region.

The subalpine zone presents four chief features. The first and most typical consists of a forest of medium density—300 to 400 trees to the acre. The trees are mostly straight and symmetrical. There is but little underbrush, the ground being covered with low shrubs of species of huckleberries, or with a growth of alpine sedges or junci, or, as is generally the case, with a dense sward of the common bear grass (*Xerophyllum tenax*). Litter is scanty, consisting of a few broken branches or tree tops. Humus is either wholly absent or but 2 or 3 inches in depth. Forests of this character are found on the ridges and slopes, mostly above 5,500 feet elevation, and represent the mature but still vigorous subalpine forest.

The second aspect is that of a forest of great density—1,000 to 2,000 trees to the acre. A tract of this character is usually littered with vast quantities of broken and dead trees, dead branches, and growing brush, consisting in the main of mountain alders, mountain ash (*Sorbus sambucifolia*), and Menziesia shrubs. There is sometimes a sparse growth of bear grass, but the sunlight admitted through the dense masses of trees is usually too scanty to permit the growth of many herbaceous plants. Such tracts represent the young and rapidly growing subalpine forest in the last stage of the reforesting process subsequent to complete destruction by burning. At the present time this type of forest is most prevalent on the slopes and summits of the lateral spurs with northern exposure, and in the saddles, or sags, in the main divides.

The third aspect is that of densely brush-covered areas with a thin forest—10 to 100 trees to the acre—rising from the midst of a sea of brush composed of species of alders (*Alnus alnobetula*), mountain ash (*Sorbus sambucifolia*), and especially of Menziesia and Azalea shrubs (*Menziesia ferruginea* and *Azalea albiflora*, respectively). There is a great amount of litter, consisting of large fallen trees, dry or in a state of decay. Humus is almost lacking, and the young growth, to take the place of the dead old, is scanty. Forest stands which present this phase are either in a state of decay, owing to advanced age, or are produced by forest fires occurring either early or late in summer when the litter was not sufficiently dry to flame, but underwent slow incineration, cooking the bases and roots of the trees. Tracts of this sort occur everywhere in the zone, but are more abundant on the slopes leading into the saddles of the ridges.

The last aspect is confined almost wholly to ridges having an easterly and westerly trend, and, in consequence, presenting their sloping sides directly north and south. The southern face in such situations may contain expanses of 50 to 500 acres having but scattered trees and shrubs, but covered with a dense and heavy growth of many species of mountain grasses. Such tracts are areas that once were heavily timbered, but have had their forest burned off, and, owing to direction and angle of slope causing too rapid drainage and evaporation, have been rendered too arid to permit a renewal of forest growth. The only litter on these tracts are the charred stumps of trees consumed by fire centuries ago. The northern slopes of such ridges usually bear a forest with the aspect of number two, unless, as in some cases, covered with rock slides, while the comb of the ridge has a dense, low-growing belt of young subalpine firs bent and twisted in all directions by the weight of the snow that is blown up over the southern face of the ridge.

The white-pine zone displays fewer aspects. There is usually a large amount of litter, consisting of fallen trees, that have accumulated for centuries, in various stages of decay. The undergrowth is mostly dense, consisting of young trees, the white fir and Merten hemlock predominating. In the low and wet places along the streams various species of shrubs, as alders and dogwood, form dense thickets. There is always a considerable layer of humus, varying in depth from 8 to 14 inches, composed of decaying vegetable débris. The forest is generally wet, often swampy, the humus serving as a sponge and preventing evaporation from the soil beneath. By reason of the considerable size of the trees the aspect of the forest is that of excessive density, but it

YELLOW-PINE GROWTH ABOUT 100 YEARS OLD IN THE LOWER YELLOW-PINE ZONE, PRIEST RIVER FOREST RESERVE.

is rather medium than otherwise, having from 150 to 400 trees 6 inches or more in diameter to the acre on tracts of second and old growth.

To the white pine zone belong the areas supporting a nearly pure growth of lodgepole pine. They are found throughout the reserve on the lower flats and terraces of the stream valleys. In some localities they are of considerable extent, the largest area being just below the south end of Lower Priest Lake and stretching thence nearly to the junction of the East Fork with the main Priest River. This character of forest is usually very dense, the areas containing from 800 to 2,000 or more trees to the acre. There is often a considerable amount of litter, consisting wholly of broken-down young growth. Where the forest has reached an age of 90 years and upwards there has accumulated a depth of humus ranging from 3 to 6 inches. The undergrowth is low and scattered, composed mainly of Pachystima, service berry, Holodiscus, and various species of alders and willows.

The forests of yellow pine present two phases. First, the areas where the preponderance of growth belongs to the yellow pine. This occurs on rocky slopes of low elevation facing the south or west. The forest floor is generally covered with grass or sedges that grow in dry soil. The undergrowth is at minimum density and is formed of low shrubs, such as Holodiscus, Opulaster, wild syringa, mountain ash, and the sanguineous Ceanothus. Humus is lacking or is a mere top dressing of dry pine needles and cones. There is no litter except where a fire has recently swept through.

The second phase of the forest occurs where the red fir replaces the yellow pine. This takes place whenever there exists a deeper, less rocky soil, heavier precipitation, and less rapid drainage.

The grassy slopes characteristic of the former phase of the zone are mostly lacking, and are replaced by a heavier and more extended growth of the shrubs previously enumerated. The forest growth is dense, in some localities ranging from 800 to 1,500 trees to the acre, but where such density exists the diameters of the individual tree are small. The litter is generally abundant, consisting of fallen trees, and the humus attains a depth of 3 to 5 inches.

AMOUNT OF AVAILABLE TIMBER.

By reference to the table on page 249 it will be seen that the estimated amount of merchantable timber on the reserve is 4,833,600,000 feet B. M. Less than 2,000,000,000 feet are contained in sizes suitable for saw logs. This shows that there is a vast amount of young growth. The large areas covered with this growth are due to the burnings of 120 to 150 years ago, the reforesting process just entering the fourth stage, or second growth. They bear, however, very nearly as great quantity of timber as the areas of old growth, by reason of their excessive density, but the diameters of the standing trees are relatively small. The availability of the timber depends on two conditions: first, accessibility, as determined by the topographical features of the country; second, the particular line of forestry policy adopted with regard to the amounts that may be safely cut without impairment of the strength of the forest. By strength is here meant the collective resistance offered by the living growth to the wind, which is by far the most destructive natural agent that operates in the basin.

It would require a long and close exploration of the reserve to estimate with accuracy the amount of timber available under the two conditions named, and the table of estimates prepared in this connection should only be taken as indicative of a rough average.

The following estimate of the total amount of standing merchantable timber is given:

	Feet.
Young growth	3,141,840,000
Second and old growths	1,691,760,000
Total	4,833,600,000

The amount accessible is estimated as follows:

	Feet.
Young growth	2,073,614,400
Second and old growths	1,353,408,000
Total	3,427,022,400

Of this the following amount may be safely cut without impairment of the forest strength:

	Feet.
Young growth	377,020,800
Old growth	270,681,600
Second growth	406,022,400
Total	1,053,724,800

The real area of accessibility is an uncertain factor. It is one that varies constantly with the price of lumber products and of labor, the character of seasons, etc.

Practically there are no areas in the white and yellow pine zones beyond reach. It is simply a matter of profit and loss in providing means of transportation from the steep upper hillsides and narrow canyons to the flats and valleys below. The possible output may also be greatly increased by increasing the cutting in each of the tracts beyond the limit here suggested.

SOUNDNESS OF THE TIMBER.

The dominant tree in the subalpine zone, *Abies lasiocarpa*, is commonly subject to heart rot at an early period in its growth. It is rare to find trees with diameters of 10 inches and upward that do not show a ring of decay at the core. The white-bark pine, on the contrary, is commonly sound even at the most advanced age. The wood is hard and tough, resisting decay to a remarkable degree, and if the tree grew in accessible localities would be of value in cases where it forms a sizable clear trunk, as is sometimes the case. The other trees of the subalpine zone are generally free from defects, except such as are caused by external violence, as breakage by wind and snow. It may be estimated that of the total growth in this zone about 60 per cent of the trees from 6 inches in diameter at the base and upward are defective from some cause. The timber in the white-pine zone contains considerable defective portions. Aside from the damage done by forest fires, which is not taken into account now, there is a great deal of heart rot, wind shakes, and gum cracks. Most of the damage occurs in the white pine, which appears to be more subject to decay here than elsewhere in the West. The percentage of defect varies with character of soil and age of growth. It is greatest on areas of old growth and on low ground, and least in the second growth and on moderately dry soils. The percentage runs from 15 to as high as 25 per cent in the former, and from 5 to 15 per cent in the latter, all species of trees included. More than three-quarters of these amounts belong to the white pine alone. Next in frequency of defect come the cedar, Merten hemlock, and western tamarack, in the order named. The most common defects are attacks by fungi, causing either decay of the heartwood or destruction of the cambium layer in the growing trees, wind shakes, gum cracks, and breakage and splitting of the trees by the excessively violent winds or snows. Aside from the agencies of man and wind, fungi are the most destructive. The white pine and cedar are especially subject to their attacks. The weakening effect of decaying heartwood on such tall trees is to render them less capable of resisting great wind stress, and therefore more liable to development of wind shakes and gum cracks. The defects at the heart of the white pine, cedar, and tamarack do not wholly destroy their usefulness, though very materially lessening the value of the individuals so affected. In shingle making, to which purpose the larger cedars are mostly put, the decay at the core, if not too great, does not matter very much, as the central portions are usually discarded in any case, and in the white pine it is a common practice at the mill to saw around the decayed core. The defects in the tamarack are chiefly gum cracks and wind shakes, due in part to the swaying of the tall trees under wind pressure. They are produced mainly in the lower part of the trunk and are pretty sure to enlarge as time passes.

The defects in the yellow-pine zone are mostly gum cracks and crooked and deformed trees. Owing to the open character of the forest in many places the wind has a free sweep. The damage is confined chiefly to the red fir, aggregating about 5 per cent, against less than 2 per cent in the yellow pine.

MEANS OF TRANSPORTATION OF LUMBER.

The only method available at the present time to transport lumber out of the reserve is by driving on Priest River to its junction with the Pend Oreille, at which point the Great Northern Railway is reached.

The Lower Priest Lake is navigable for steamers of any draft; the upper, owing to shallowness in the Thorofare, only for boats of light draft. Above the upper lake the river can be utilized for driving for several miles by removing the snags that block it here and there. Not many of the side streams can be used for this purpose without expensive improvements in their beds. Some, notably those that enter from the east, are full of big bowlders and interrupted by series of falls, while those from the west either have a sluggish current which meanders through marshy expanses or are much obstructed by windfalls and in some cases by rocky ledges. The valleys on the west half of the reserve, however, with their easy slopes, offer good opportunities for the construction of logging roads to bring their timber to the main river. The water in the river usually maintains until the 1st of August a sufficient depth to permit driving, but by building a dam across the point where it leaves the lake, an undertaking easily accomplished, a sufficient volume of water could be held back in the lake to float logs down Priest River at any time. The area in the southeast corner of the reserve fronting on Pend Oreille Valley is adjacent to the Great Northern Railway, and the timbered valleys are easy of access from that side by means of logging roads. The most feasible way to utilize the water in the tributary streams for logging purposes would be to construct flumes and turn the streams into them.

LOCAL DEMAND FOR LUMBER.

There is scarcely any local demand. Small quantities of timber are used locally for fencing, building material, shingles, logs, etc., but the total consumption for these purposes is insignificant. There are no sawmills in the reserve. The nearest point at which a sawmill is located is Sand Point, at the northwest corner of Lake Pend Oreille. If the lumber on the reserve could be obtained without trespass and its attendant difficulties, it is pretty certain that sawmills would soon be established near the outlet of Priest River, in the Pend Oreille Valley, for the manufacture of lumber and shingles. The quantity of tie timber on the reserve is immense, and railroad ties are nearly always in demand at good prices to the producer.

TIMBER CUTTING.

The cutting done in the past on the area now included in the reserve was chiefly in connection with the construction of the Great Northern Railway some years ago. The timber taken was almost wholly tie timber and piling, consisting of young trees 12 to 20 inches in diameter, of cedar, hemlock, spruce, and tamarack. Most of the cutting was adjacent to the line of the road where it passes through the southeast corner of the reserve. Along a distance of about 6 miles the tie timber on the north side of the road was cut nearly 90 per cent on lands within one-half a mile, and from 35 to 50 per cent on lands a mile, from the line of road. Since the road was completed small quantities of ties have been cut on lands adjacent to the main Priest River from the outlet into the Pend Oreille to a point about 12 miles above. The cutting done at the present time consists of clearings, wood for fuel, building, and fencing. During the last summer (1898) parties were cutting the white pine on Lower West Fork and floating it to the Great Northern Railway crossing of Priest River, whence it was shipped. Ostensibly the cutting was done with a view of furnishing samples of western white pine to lumbermen in the East. The trees were felled on the Lower West Fork and along the main Priest River, squared in the forest, and floated down the river to a boom at Priest River Station.

PRESENT CONDITION OF THE FOREST—FIRES.

In the foregoing pages the forest conditions have been detailed with reference to the state of the growing, more or less commercially valuable timber. It now remains to examine the extent of the actual area covered with a forest of this character. The area capable of growing a forest, and that did grow one not very many years back, is about 90 per cent, or 600,000 acres. Of this amount about 60,000 acres belong to the subalpine zone, leaving 540,000 acres as the area capable of producing merchantable timber. The density of the present forest varies considerably. On small tracts in the white-pine zone it may run as high as 120,000 feet per acre, including all timber above 8 inches diameter at the butt, and it may dwindle to 2,000 feet or less, as in some localities in the yellow-pine districts. Had there been no fires in this reserve, 30,000 feet per acre might be safely assumed as a fair average, including all kinds of merchantable timber above 8 inches basal diameter. Given an area of 540,000 acres, we should have a total of 16,200 million feet. But the entire amount on the reserve should be greater. In the lower portion of the subalpine zone there are many tracts containing appreciable quantities of white pine, tamarack, cedar, and red fir. There are probably 10,000 acres of this that would yield an average of 3,000 feet per acre, adding 30,000,000 feet to the figures above. We should have then as a total 16,230 million feet as the amount of standing timber on the reserve. These figures are confidently believed to be under rather than above the true value. Large areas where the forest is untouched have an extremely dense growth, and the long slopes of the ridges and spurs increase the actual acreage considerably over the horizontal measurements, which are the only ones considered here. By reference to the tables of standing timber on the reserve, it will be seen that the estimated amounts standing at the present time are as follows:

	Feet.
Saw timber	1,903,600,000
Ties, at 20 feet per tie	2,720,000,000
Telegraph poles, at 100 feet per pole	210,000,000
Total	4,833,600,000

This leaves a total of 11,396 million feet unaccounted for. This immense quantity of timber, of which the total cutting for all purposes, clearings, etc., does not exceed 20,000,000 feet, and is doubtless much below this figure, has been burned during the last thirty years—burned and wasted to absolutely no purpose. The estimates made on this point while examining the forest were as follows:

	Feet.
Saw timber	4,488,800,000
Tie timber, at 20 feet per tie	4,900,000,000
Telegraph poles, at 100 feet per pole	600,000,000
	9,988,800,000
Add for clearings, cuttings, etc	20,000,000
	10,008,800,000

This leaves 1,387 million feet unaccounted for. We will assume, what is doubtless true, that the burnt areas were not necessarily as heavily timbered in all their parts as are the growing ones now. We can not, of course, be certain on this point. Our estimates must be based on the character of the forest that adjoins the burnt tracts, and on the number and size of the partially consumed stumps and other wreckage.

To keep our estimates low we will therefore ignore the balance of 1,387,600,000 feet, although this amount could, with safety, enter into the estimate as representing other species than those furnishing merchantable timber. The amount could even be increased. Thousands of acres of the subalpine forest have been totally destroyed, leaving not a tree of the original growth alive. It is true that the trees which form the bulk of its growth have no market value at the sawmill, but for local use, such as mining timbers in small workings situated in the high elevations, where no other species are obtainable, the subalpine fir and white-bark pine are vastly superior to the lodgepole pine, often used elsewhere for this purpose. We should not exaggerate if there were added another billion feet to our fire losses from that source.

This timber has not all been literally consumed by fire. The forest fires in this region seldom burn the timber completely. They kill more by cooking the roots and the lower portions of the trunks than they consume. The severe wind storms of the fall and winter throw down great quantities of both dead and living trees, soon completely denuding the burnt-over area. Of the 540,000 acres below the subalpine zone, 280,000 acres average now less than 12,000 feet per acre of all sizes, an insignificant amount for a region with normally so dense a forest growth as the Priest River Basin, while 260,000 acres have less than 7,300 feet per acre.

These averages, however, do not show the real state of the matter. Of the 540,000 acres that make up the white-pine and yellow-pine zones, there are not 80,000 acres that are not seared by fire. Excepting a small area of about 1,600 acres along the Lower West Fork, there is no body of timber of 1,000 acres, or even 500 acres, extent not scorched

BURNT AREAS NEAR REEDER CREEK, PRIEST RIVER FOREST RESERVE; DEAD TIMBER THROWN DOWN BY WIND.

by fire. In the two lower zones there are over 200,000 acres on which the destruction is practically complete. In the subalpine zone at least 40,000 acres of the 60,000 have been more or less injured by fires.

One meets with burnt areas everywhere—in the old growth, in the second growth, in the young growth, and where the seedlings that are beginning to cover the deforested areas have just commenced to obtain a fair hold. The burnt tracts are in large blocks, thousands of acres in extent, and in small patches of 15 to 50 acres which extend in all directions through the forest, which at a distance is apparently green; sometimes they are in broad swaths, sometimes in narrow, tortuous windings just sufficient to open a lane for the destructive high winds to tear the living forest down. The burnt areas are scattered all over the reserve, but the largest amount of damage lies within the zone of the white pine, by reason of its greater extent and peculiar susceptibility to destructive fires. The most extensive plats of burnt forest are found in the northern and western portions of the reserve, corresponding exactly to the regions that are supposed to contain the largest areas of mineral-bearing country.

Forest fires occurred in the Priest River Basin ages ago. About one hundred and fifty years ago the area surrounding the lower and, in part, the upper lake was burned over to the extent of more than 60 per cent. Later, a large tract south of the lower lake shared the same fate. This is proved by the great quantities of young growth, less than 100 years old, that exist in many places with very old trees in their midst. After these fires came an interval of sixty to seventy years with but few burns, involving only small areas. The beginning of the fires of modern times in the basin dates back about thirty years. They owe their origin mainly to the universally wanton disregard for the value of the growing forest in general, and for public property of this kind in particular, which is so unfortunately prevalent in the West. Many of the fires have originated within the present boundaries of the reserve. Those of late years have all started there. Others have come in by way of the Pend Oreille Valley, from the Metaline mining districts, and from other real or supposedly mineral districts. Still others have originated east of the Pend Oreille divide near Lake Pend Oreille, and between it and the Kootenai River, thence spreading westward into the basin. The areas adjoining the reserve are indeed more devastated by fires than those contained within it. Prospectors, hunters, and trappers have kindled most of the fires, and still continue to do this. Large areas in the main Priest River Valley, in the dense old and second growths, have been burned by the various supervisors in charge of the wagon road from Priest River Station to the south end of Lower Priest Lake. They set fire to the heaped-up brush along the side of the road, and the fire spreads thence into the adjoining timber without check or hindrance. This is done as an expeditious and inexpensive way of improving a wagon road.

The pecuniary loss to the Government, and to the community in whose neighborhood the burnt areas are situated, is immense. The marvelous apathy of public sentiment at the destruction of such important sources of wealth as the Western forests can only be accounted for on the supposition that the enormous interests involved and the vast losses that the forest fires cause are never realized. It is true that the forest growth in the Priest River Basin has been exceptionally heavy, and that therefore the losses elsewhere, on areas of like extent, have not been so great, but they are nevertheless of sufficient magnitude in any locality to demand a speedy and decided change in public sentiment.

Our estimates place the fire loss in forest material throughout the Priest River Basin for the last thirty years at 4,488 million feet of saw logs, 245,000,000 railroad cross-ties, and 6,000,000 telegraph poles. These have a monetary value in the forest about as follows:

4,488,800,000 feet of logs, at 50 cents per thousand feet	$2,244,400
245,000,000 ties, at 2 cents per tie	4,900,000
6,000,000 telegraph poles, at 5 cents per pole	300,000
Value of young growth during thirty years	1,500,000
	8,944,400
Less depreciation by windfalls, etc	447,220
Net loss	8,497,180

These figures are based on the low and customary stumpage that obtains now. The stumpage loss, however, is in fact but a small percentage of the real loss. The community that has in its midst, or adjacent to it, a large area of mature forest in a state of good preservation has a mine of wealth, if not at once in the not far-distant future. The working and business interests of such a community are the chief losers in the destruction of the neighboring forest. It has in the past been customary to compute the loss from forest fires on the basis of stumpage, but any account that does not include the losses to the working and business interests of the community most nearly interested fails to gage the matter properly.

To bring the products of the forest to the hands of the consumer requires a large amount of labor of various sorts. Large sums of money are brought in and set loose in different business channels. Taking this into account, let the computation be based on the value of the product when ready for consumption at the mill or railroad track.

4,488,800,000 feet lumber, at $10 per thousand	$44,888,000
245,000,000 railroad ties, at 20 cents per tie	49,000,000
6,000,000 telegraph poles, at 25 cents per pole	1,500,000
Value of young growth during thirty years	15,000,000
	110,388,000
Less depreciation during thirty years	4,447,220
Net loss	105,940,780

BURNT AREAS NEAR REEDER CREEK, PRIEST RIVER FOREST RESERVE; DEAD TIMBER THROWN DOWN BY WIND.

This amount could readily be further increased. There is the added loss to the sections obliged to import lumber from long distances, owing to the supply near home having been burned up. Then the value of the young growth is placed low—less than 90 cents per acre per year—and no account is taken of the utter destruction of the humus of the forest floor which usually ensues. The humus is absolutely necessary to a first-class growth of such species as the western white pine, the tamarack, the cedar, and the hemlocks; and one of the most serious results of forest fires is the destruction of this vegetable layer. On areas where the burning of it has been complete, it may require fully one hundred years before a sufficient depth has accumulated to make possible the growth of the species enumerated. It rarely requires less than twenty years, unless the situation is exceptionally favorable as regards moisture.

When it is considered that forest fires can easily be kept in check, the destruction they bring seems all the more deplorable. All that is required is an active, healthy public demand, in the localities, counties, or States where they occur, that they must cease, and a proper enforcement of the laws bearing on the subject. But so long as people living in the forested districts believe in and applaud the sentiments frequently heard uttered on the reserve, so long fires will rage, unless stopped by Government interference. It has been a common occurrence to hear such remarks as, "If the Government intends to guard and preserve the timber from fires and prevent unlimited cutting, we will try to burn up what is left as soon as possible;" or, "Since the reserve has been set aside every prospector carries an extra box of matches along to start forest fires with." These sayings were not made in a spirit of bravado, but with the conviction that the course outlined was the proper one to pursue to show their disapproval of Government interference in what they have heretofore considered their rights, namely, to cut, slash, or burn, as convenience or fancy might dictate. Such sentiments are common almost everywhere in the forested region in the West among those classes whose occupations bring them into closest touch with the living forest. The other classes care but little one way or another. It is deplorable that such should be the case.

EFFECT OF FIRES ON REPRODUCTION.

The after effects of fires depend on the season of the year in which they occur, the supply of moisture to the portion, slope, or terrace burned over, and, last and most important in the white-pine region, the more or less complete incineration of the humus, as this layer of mold is indispensable to the growth of a commercially valuable white-pine forest. By humus is here meant the topmost layer of the forest floor, composed of decaying pine needles, wood, and vegetable débris of all sorts. It is always in an active stage of decay, accelerated by its ability to retain moisture and by the vast number of fungi that send their mycelia through it in all directions. It is not a fertile bed for grasses or small herbaceous plants, but for certain forest trees it is indispensable. None of the conifers that normally belong to the white-pine zone possess a taproot. They penetrate into the layer of soil but a few feet, sending out their roots widely just under the humus. Forest fires and their after effects vary more or less in different regions. The account here given of the fires within the Priest River Reserve are therefore not to be considered as furnishing a standard applicable to other sections.

Forest fires prevail at three seasons of the year: Spring, from late April to June; summer, from the middle of July to the beginning of September; and fall, from the beginning of September to the middle of October. Conflagrations during the first two seasons are more common; during the latter they are comparatively rare and are mostly survivals of the summer fires not quenched by the fall rains. The spring fires burn slowly and flame but little; the humus incinerates slowly, and many patches are thoroughly drenched with contained moisture and do not burn; the subalpine areas are covered with snow, or at least are extremely wet, and fires can not readily spread beyond the lower zones, therefore not across ridges high enough to touch the upper zones. The summer fires find the humus, if not thoroughly dry, yet sufficiently dry to permit rapid incineration, and conifers are ready to shed their leaves, which now contain little moisture but sufficient terebinthine matter to flame furiously, communicating the fire to whatever dead branches exist in the trees. The summer fires therefore flame considerably, and when fanned by a strong wind, which frequently happens in this basin, open to the south, burn furiously. Fires at this season are most destructive, and encounter no particular check to their progress. The fall fires resemble those that occur in the spring, but are even less extensive.

Fires in the subalpine zone occur in the summer. If very early they resemble the spring fires in the zones below. Occurring on the high ridges, the wind has a better chance to accelerate their spread and create a hotter fire, which burns the humus completely.

Reforestation in this zone proceeds more or less rapidly according to the intensity of the fire and the slope exposure. In general it is extremely slow, but usually the same species that occupied the ground originally come in again as the predominant forest growth. Sometimes in the lower edge of the zone a preponderance of the lodgepole pine forms the growth, but usually it is either the subalpine fir or white-bark pine, or both, that come in on the burnt tracts. On areas where the fires ran in the early summer or fall, or on humid northern slopes, where they occurred during the summer and did not wholly destroy the humus, although cooking, killing, and partially burning the forest, there come in, as the first attempt at reforesting, dense masses of Menziesia shrubs with a liberal admixture of alders and mountain ash. These shrubs exist everywhere throughout the subalpine zone in certain proportions at all times. Their roots extend far below the humus into

FIRE STARTED BY ROAD SUPERVISOR IN JULY, 1897, IN THE WHITE-PINE TIMBER 1 MILE BELOW THE JUNCTION OF THE EAST FORK AND PRIEST RIVER.

the underlying rocky soil, and they are not exterminated by a slow spring or fall fire. After the forest is burned they often attain an excessive development. Their density is such that they effectually choke out all seedlings of the subalpine forest trees for long periods of time. Eventually, however, the original sylva again covers the ground and the shrubs die out. The new forest develops great compactness, especially on slopes well provided with seepage; the trees are set close and are too slender and tall to resist effectually the force of wind and snow. In consequence large numbers are uprooted annually, nevertheless, the forest regains its normal open character very slowly. On slopes that have been ravaged by summer fires where the wind has assisted to fan the flames the destruction is often complete to the entire extermination of the roots of the shrubs. The first vegetation to appear after such a fire comes in the form of small herbaceous plants, prominent and characteristic among them being *Epilobium angustifolium*. The shrubby growth comes more slowly, fifteen to twenty years usually passing before the ground is fairly covered with it. After that reforestation proceeds as on the burnt areas of the early summer and fall. When the exposure of the clean-burnt slope is toward the south the primary effect is sterility. The impact of wind and rain is sure to carry considerable of the loose soil of the denuded slope into the canyons below, leaving it bare and rocky. If, however, sufficient soil is left, various species of alpine grasses and sedges obtain a footing. Later the bear grass supplants the grassy growth, and in its turn is crowded out by dense masses of the vellum-leaved Ceanothus (*Ceanothus velutinus*) or the thin-leaved huckleberry (*Vaccinium membranaceum*), which finally prepare the soil for a forest growth of the original species, more or less mixed with the lodgepole pine. The time required for these changes to take place is not known, but must be centuries.

Fires in the white-pine zone are more widespread and destructive than elsewhere. The humus and litter are much greater and the trees more susceptible to the killing effects of the heat. Most of the destruction is wrought by the slow incineration of the humus, less destruction by the flaming process. Hundreds of thousands of trees were seen on the reserve that presented no other evidence of having been subjected to fire than that the leaves were turned red. There had been no flaming, nothing but the slow cooking of the roots, which, however, killed as surely as the flames could have done. The wind has less sweep in the white-pine forest than on the subalpine slopes; therefore it is rare to find an area burned clean by the forest fire. After a fire the wind soon throws down the dead trees, and in a few years, when the mass is dead and dry, a second fire thoroughly cleans up the accumulated wreckage. The phases exhibited by the reforesting process in the white-pine zone are normally five, up to the time that the forest again begins to assume the appearance characteristic of the old growth, but sometimes one of these phases is lacking. The time required for reforesting is exceedingly uncertain, and the bulk of the species of trees that at first appears are almost invariably others than the white pine. The factor that determines the length of time that must intervene between a burning and a reforesting with the original species is moisture supply. A burnt-over valley terrace exhibits best the different aspects of the process. Let us suppose that it is a case where the dead trees have been thrown down by wind and the débris cleaned up by a second fire. The first effect is sterility, brought on in part by excessive evaporation, producing aridity, and doubtless in part by chemical changes in the top layer of the soil, for it is a notable fact that the iron in the soil, previously existing as sulphurets, is desulphurized and oxidized, coloring the soil shades of red and brown. On this sterile surface mosses begin to grow, *Polytrichum juniperinum*, *Funaria hygrometrica* and *Leptobryum pyriformum* being the most common. Gradually herbaceous plants come in and a top layer of mold is formed, representing the first stage. The second commences when shrubs begin to obtain a foothold. In dry situations, like the valley terraces in the Priest River Basin, the principal shrubs are *Ceanothus velutinus*, *C. sanguineus*, *Salix flavescens*, strictly a bush, *Populus tremuloides*, and *Amelanchier alnifolia*, also shrubby. These species add to the top layer of mold one in which decaying leaves constitute the principal part, not deep but sufficiently retentive of moisture to serve as a seed bed for the conifer that comes in at the third stage, the lodgepole pine. It comes in with extreme density, soon driving out nearly all other vegetation, herbaceous and shrubby. It may persist in that aspect for twenty-five to thirty-five years, but is gradually thinned out by natural processes and the forest floor begins to be covered with a sward of sedge, usually *Carex geyeri*, and a thin growth of shrubs, such as *Pachystima myrsinites*, *Vaccinium cæspitosum*, *Holodiscus discolor*, and *Opulaster malvaceus*. This is the humus-forming period, which may persist for more than a hundred years. As the humus accumulates the fourth stage of reforesting begins with species of the original forest again occupying the area, but the restoration of the ancient balance between the species is a very slow process. The fifth process is simply the growth of the young trees as they progress toward the second and old growths.

When the white pine is burned on a tract of low-lying land supplied with plenty of moisture, and the trees are thrown down, they often remain as they fall until they decay. The logs do not always dry out sufficiently to burn the second time, or they burn but partially. If the humus is burned entirely out to the underlying soil, shrubs, willows, alders, and the like are the first to put in an appearance. As the fallen logs decay a humus is formed that serves as a germinating bed for seeds of the Merten hemlock and the cedar, which come in in immense numbers and soon cover the ground with a compact mass of seedlings. The Merten hemlock, obtaining a hold on the soil in such localities, often persists for ages to the almost complete exclusion of the white pine and tamarack. Where the humus is not completely wiped out,

BURNT WHITE-PINE FOREST, PRIEST RIVER FOREST RESERVE; DESTRUCTION TOTAL.

the white pine, tamarack, and white fir usually come in from the first, mixed to some extent with alders and willows.

The yellow-pine zone has little humus—often none at all. Fires in these areas burn rapidly, and always with a flame. The grass that covers the forest floor is the chief agency in spreading the conflagrations. The fires occur in spring, summer, and early autumn, especially in late summer when the grass is dry. The destruction is greater where the red fir prevails than where the yellow pine is the principal species. The yellow pine resists the fire better than any other forest tree in this region, while the red fir is readily killed. The after effects of the fires here also depend on the moisture supply. Both the yellow pine and the red fir will germinate without the humus layer, provided there is sufficient seepage under the soil. Seeds of the yellow pine will germinate if there be but a moderately grassy forest floor for their reception. Where the yellow pine grows the forest is open and the ground supports a grassy growth. The fire runs rapidly, but does not kill out the grass, which comes up again in the fall of the same year or the following spring. The fires, however, destroy the year's seedling plants, thus preventing reproduction, and weaken the old trees by development of gum cracks and barkless pitch streaks that furnish an entrance for subsequent fires to the center of the tree. Where red fir prevails in the zone there is a heavier growth of timber and brush, with some humus. The fires often sweep such areas entirely clean of living timber. If there is no seepage near the surface the soil is rendered arid, as in the white-pine terraces, and goes through nearly the same course of reforesting, except that in place of the lodgepole pine white fir often comes in. Where there is an abundance of seepage, as on the humid slopes of the spurs, the red fir may come in as the first tree in the reforesting process after a short course of willow and Ceanothus growth.

It may be well to summarize briefly the conclusions reached. The effect of fires in the subalpine zone is to cause permanent deforested tracts on the southern slopes above water level;[1] below this, when exposure of slope is toward the west, north, or east, brush-covered ridges for an indefinite period, reforesting slowly, but with preponderance from the first of the species that composed the original growth.

The after effects of fires in the white-pine zone are decided sterility of the soil on valley terraces, coupled with aridity due to excessive evaporation; in low places, and on north, east, and west slopes, densely brush-covered tracts. Reforesting proceeds slowly on lands of the former character, but more rapidly on the latter, provided the humus is not wholly destroyed. Lodgepole pine is usually the first tree in the reforesting process on the bench lands; cedar, Merten hemlock, and Engelmann spruce on the lowlands and on humid slopes; on south slopes,

[1] Water level is the line on any given slope where the seepage from the crest above first comes to the surface. It varies with changes in angle of slope, dip, and strike of the strata, fissuring of the rock formation, etc.

lodgepole pine and red fir. The approximate time required to reestablish the white-pine forest through natural processes is from eighty to one hundred and fifty years on bench lands; twenty to eighty years on lowlands and north, east, and west slopes of mountains; and apparently centuries, in some cases, on south slopes. Approximately sixty to one hundred and twenty years is required after reestablishment of the forest before it will supply merchantable timber. The total time required, under the most favorable circumstances, for the white-pine forest to furnish merchantable timber after destruction by fire is one hundred and sixty to two hundred and seventy years on bench lands and terraces, eighty to two hundred years on lowlands and humid slopes of the elevations, and several centuries on the dry southern slopes.

The results from fire in the yellow-pine zone are: Where the yellow pine predominates, entire cessation of reproduction by the repeated burning of the seedlings and very young trees, slow but certain destruction of the large growing timber, and enlargement of the grass tracts, which eventually become covered with brush growth; where the red fir is the prevailing tree, excessively dense development of brush on the burnt-over land. Reforesting in the yellow-pine districts begins as soon as fires cease, with yellow pine, red fir, and lodgepole pine; and in the red fir districts, with red fir and white fir on the drier tracts and lodgepole pine on the more humid. The brush period lasts from fifteen to fifty years before the original type of forest is reestablished, but where lodgepole pine growth has become firmly fixed the time is indefinite.

AGRICULTURAL LAND.

The Priest River Reserve is a forest region. Its natural peculiarities are such that it can never become an agricultural section, and all efforts to make it such should be discontinued. Its chief value lies in the immense forest growth it is capable of maintaining, and in whatever mineral deposits time may disclose.

The agricultural lands amount to about 9,990 acres, distributed as follows:

	Acres.
East half of reserve	1,850
West half of reserve	6,940
Pend Oreille Valley	1,200
Total	9,990

Situated, as to localities, as stated in table on pages 251–252.

These lands consist of tracts covered with coarse sedges or grass; sphagnous bogs capable of being reclaimed; alder and willow swamps too wet for forest growth; and, in the valley of Pend Oreille River, of grass lands subject to overflow, and of cleared lands on the benches adjacent to the streams. The agricultural lands within the reserve are

DESTRUCTION OF A MIXED FOREST, PRIEST RIVER FOREST RESERVE.

found adjoining the streams. They are nearly always wet and swampy, but may be reclaimed by ditching. The bulk of these lands is situated in the western half of the reserve, where the rock formation is softer and in consequence the valleys are broader and more level. Some tracts are clear of brush; others require removal of the mass of willows and alders that covers them. The clearing of the latter class is not difficult and only moderately expensive.

All of the partially clear or grassy tracts are held by settlers, as are some of the alder and willow swamps. The natural meadows are utilized for hay production, the sedges and grass furnishing a sort of coarse hay. In a few cases small patches of the boggy meadow land have been ditched. In such cases crops of oats, potatoes, and common garden vegetables have been raised. Along the Lower West Fork a few acres of the natural meadows have been seeded to timothy. Nearly all these lands are subject to frost at any time during the growing season. Crops of potatoes or garden vegetables are therefore never certain. There is no market for farm products within the reserve. Were such articles produced in greater quantities than the home demand required they could not be shipped. There is no cheap transportation available to the railway, and if there were the producer would come into competition with like articles from other sections where they can be grown much cheaper.

The agricultural lands are separated by blocks of green or burnt forests. If any attempt at segregation is made, they will have to be separated—each small parcel by itself—in order to avoid cutting out the intervening areas of timber from the reserve.

The lands in the Pend Oreille Valley are situated in the southeast corner of the reserve. Some consist of low flats near the river and are periodically inundated, others are clearings made in the yellow-pine timber on the bench lands. These lands are far more valuable for agriculture than those in the Priest River Basin, and being nearly in a body, can readily be segregated.

The actual values of all agricultural improvements in the reserve to date are insignificant. There are many squatter's claims, but only a minimum of cultivation has been done on any of these. There is not a single holding that produces nearly enough for the support of even a small family. Agricultural settlements date back seven years, but the total of all lands in the basin brought under the plow since that time does not exceed 70 acres. Of this, perhaps 30 acres represent brush clearings, 20 acres ditched and drained meadows and bogs, and 15 acres clearings on bench lands burned off by forest fires.

Agricultural improvements on the lands in the Pend Oreille Valley are of a more substantial character. Between 150 and 200 acres are under the plow there. In the heavy timber south of Lower Priest Lake considerable land has been surveyed and subdivided, especially in township 57. There is here scarcely a quarter section, on any even-numbered section, carrying a good body of white pine that has not a squatter's claim on it, ostensibly for agricultural purposes; yet it is a positive fact that after seven years of settlement there is not in the basin a total of 5 acres cleared from the living white-pine forest.

Such claims at the present time consist simply of a log cabin of the rudest kind surrounded by a "clearing," which means a more or less completely burnt area involving the destruction of 1,000,000 to 4,000,000 feet of merchantable timber. These burnings were made with the purpose in view of establishing a lawful holding with habitation and improvements. The parties claiming these tracts live on them but a short time during the year, there being absolutely no way to gain a livelihood from the land with its present "improvements."

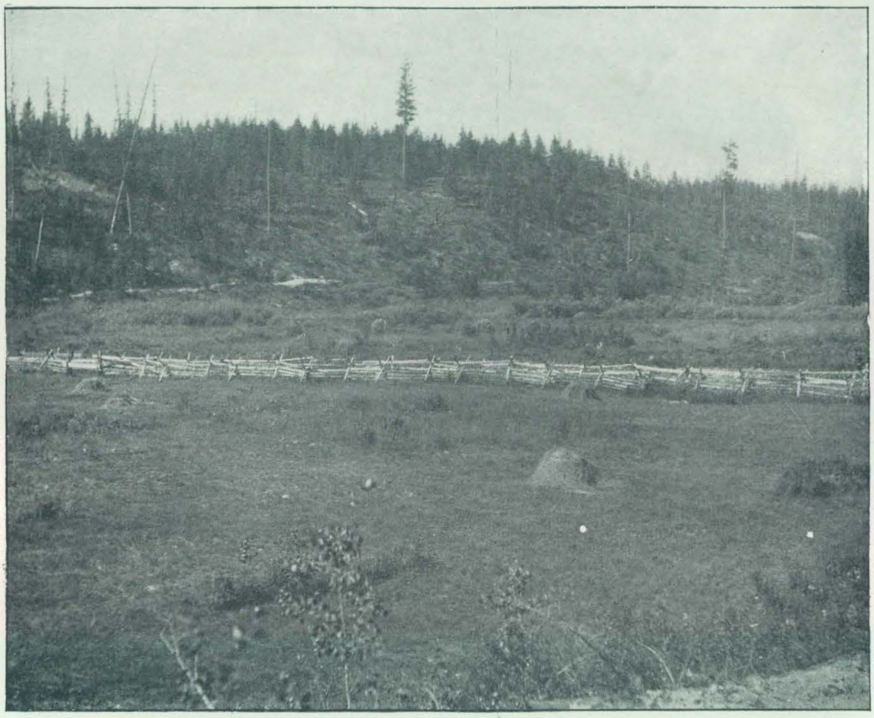
The boggy meadows and brush-covered tracts along the streams have here been considered as agricultural lands. That has been done for the reason that under proper supervision and rules agricultural operations on such lands need not necessarily infringe on the forest. It would be an entirely practical matter, however, to drain these lands at small expense, when they would soon become covered with a dense forest growth. No sheep are pastured in the reserve. Several hundred head of stock belonging to settlers living south of the lower lake range through the white-pine forest, but they do no material damage.

MINERAL RESOURCES.

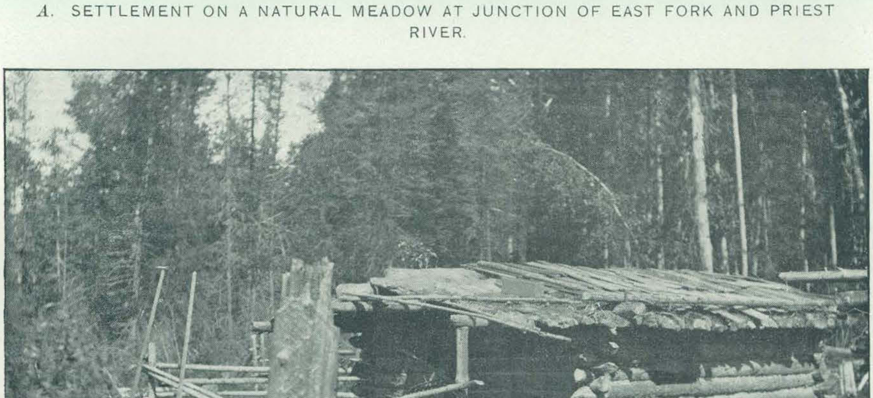
At the present time there are known to exist three mineral-bearing belts, one in the region above the upper lake, one in the central portion, and one midway between the lower lake and the south line of the reserve. Two of these belts have their long diameter easterly and westerly, and very likely stretch entirely across the reserve, while the northern one lies in a northerly and southerly direction. A great many quartz claims have been located in the mineral-bearing zones. There are none sufficiently developed as yet to prove the region a commercially profitable one in the valuable metallic minerals. It is well within the range of possibility that profitable discoveries will eventually be made in this direction.

CONCLUSIONS.

The Priest River Reserve is admirably situated for sylviculture. It needs no experiments in this direction, but merely immunity from forest fires and encroachments, ostensibly for agricultural purposes, but in reality for purposes of rapine on the merchantable forest. If protected, nature will do the reforesting. It is a demonstrable fact that unless active measures are taken for policing the reserve the present timber will soon share the fate of the other portions of the once magnificent forest. Mere reserve lines will have no effect whatever in



A. SETTLEMENT ON A NATURAL MEADOW AT JUNCTION OF EAST FORK AND PRIEST RIVER.



B. SQUATTER'S HUT NEAR REEDER CREEK.

preventing the destruction so long as public sentiment regarding forest preservation remains indifferent. The forest-fire evil is gigantic and appalling. If not checked, within twenty-five years there will be no accessible forests to furnish lumber products between the Rocky Mountains and the Cascades except such tracts as are under private ownership. Up to the present time the public has not suffered any particular inconvenience from the fires, but signs are rapidly multiplying that a pinch is beginning to be felt in the home timber supply. If the next ten years sees as large a percentage of burnt-over tracts as the last decade, the pinch will become decidedly painful. To combat the evil heroic measures are necessary. A condition confronts us that is not a mere distant shadow, but a stern present reality. To compromise it is to stultify ourselves. It will never cease so long as there is an acre of public forest to burn unless we firmly put an end to the evil and accomplish by coercive measures what an appeal to logic has failed to produce. The Priest River Reserve as a fire-swept region is no worse devastated than many other regions in Idaho and Washington. There are, however, in some other places compensation, small as it is, in the fact that portions of the denuded tracts are utilized for agricultural purposes. In this reserve, on the contrary, for the tens of thousands of acres burned over and the millions of dollars' worth of timber destroyed there is absolutely no gain to show. If it is intended to make a permanent reserve of the Priest River Basin, agricultural settlements should be rigorously confined to the parcels of land now naturally devoid of timber. I do not consider the burnt tracts as coming under this category. The denuded areas are still to all intents and purposes timber lands, requiring only sufficient time for reforesting. It would be better to exclude agricultural operations altogether from the reserve. Failing in this, no claim should be permitted to extend into the forest, even if it became necessary to break up the legal subdivisions into fractional parts. Existing squatters' claims on the timbered lands in the reserve should be ignored as regards any acquired "rights."

To prevent further destruction, the reserve should be policed. There are no tracts of equal extent in this region that can be guarded so easily and with so little expense. The past burnings have nearly surrounded it on three sides with denuded areas, which for years to come will act as natural ramparts. The danger lies from within and from along the south line. To guard it effectually, a patrol of six men from the 1st of April to the 15th of October, during the first year, furnished with at least twelve horses and the necessary equipments, would be required. Two stations should be provided for the patrol, located on the natural meadows of the reserve, so as to furnish the necessary pasturage and hay for the animals. Buildings suitable for quarters should be erected, for which the adjacent forest would furnish the material. There should be one station just above the junction of the East Fork and main Priest River, and the other on Reeder Creek, about 4 miles west from the lake shore. During the summer the patrol, in conjunction with police duties, should build trails to connect the stations and the different portions of the reserve. The burnt areas, with their huge masses of débris, make traveling without a trail slow, and in many places impossible. Trails should be built as follows: One from the south end of the lower lake along the lake shore to the north end of the reserve, following the valley of the Upper Priest River to its head; one from the point where the present wagon road crosses Blue Creek to the summit of Priest River Range, along this creek or on adjoining slopes; one up the East Fork to the summit of the range; one up Bear Creek, and one up Caribou Creek, both to the summit of the range; and, on the west side, a trail from the south line of the reserve, on the west bank of the river, turning up lower West Fork and following it to its head, thence along the Pend Oreille divide to the north end of the reserve, and turning southeasterly down Gold Creek to its junction with Upper Priest River, thence along the west side of the lake and river to a point opposite the junction of East Fork and Priest River, which should there be crossed. From this trail side trails should be run as necessity may demand.

This system of trails, with the roads already existing, would render all the vulnerable portions of the reserve easy of access and capable of being thoroughly patrolled. After the first construction of these trails, three men with the necessary horses would be sufficient to police efficiently the entire area embraced in the reserve as at present limited.

TABLES.

LIST OF SPECIES.

Species of forest trees.

I.—ALWAYS ARBORESCENT.

Pinus albicaulis	White-bark pine.
P. murrayana	Lodgepole pine.
P. ponderosa	Yellow pine.
P. monticola	Western white pine.
Abies grandis	White fir.
A. lasiocarpa	Subalpine or balsam fir.
Tsuga mertensiana	Merten hemlock.
Thuya plicata	Cedar.
Pseudotsuga taxifolia	Hemlock-spruce, red fir, etc.
Picea engelmanni	Engelmann spruce.
Larix occidentalis	Western tamarack.
Betula occidentalis	Western birch.
B. papyracea	Paper or canoe birch.
Populus tremuloides	Aspen.
P. balsamifera	Balm of Gilead.
P. trichocarpa	Cottonwood.

SQUATTER'S CLAIM IN WHITE-PINE TIMBER, SHOWING USUAL IMPROVEMENTS ON THIS CLASS OF CLAIMS.

SQUATTER'S CLAIM IN WHITE-PINE TIMBER, SHOWING USUAL IMPROVEMENTS ON THIS CLASS OF CLAIMS.

II.—VARYING FROM SHRUBS TO TREES.

Amelanchier alnifolia	Service berry.
Salix nuttallii	Nuttall willow.
S. lasiandra	Willow.
Acer glabrum	Maple.
Prunus douglasii	Cherry.
Juniperus virginiana	Red cedar.
Taxus brevifolia	Yew.

Species of trees in the Priest River Reserve utilized as lumber trees.

Pinus ponderosa	Yellow pine.
P. monticola	Western white pine.
Tsuga mertensiana	Merten hemlock.
Thuya plicata	Cedar.
Pseudotsuga taxifolia	Hemlock-spruce, red fir, etc.
Picea engelmanni	Engelmann spruce.
Larix occidentalis	Western tamarack.
Populus balsamifera	Balsam poplar.
P. trichocarpa	Cottonwood.

PROPORTION OF SPECIES.

Proportion of trees composing the forests.

I.—IN THE ENTIRE FOREST AREA[1].

Pinus monticola	33
Larix occidentalis	25
Pseudotsuga taxifolia	15
Abies lasiocarpa	8
Pinus murrayana	7
Thuya plicata	6
Picea engelmanni	3
Tsuga mertensiana	2
Pinus ponderosa	(2)
P. albicaulis	(2)
Abies grandis	(2)
Betula papyracea	(2)
B. occidentalis	(2)
Populus tremuloides	(2)
P. trichocarpa	(2)
P. balsamifera	(2)

II.—IN THE SUBALPINE ZONE.

Abies lasiocarpa	70
Pinus albicaulis	28
Picea engelmanni	1
Larix occidentalis	(2)
Pinus monticola	(2)
P. murrayana	(2)
Populus tremuloides	(2)
Pseudotsuga taxifolia	(2)

[1] In this table are included only individuals of the species enumerated having diameters near the ground of 4 inches and upward and showing a distinct trunk.

[2] Trifling.

III.—IN THE WHITE-PINE ZONE.

Pinus monticola	42
Larix occidentalis	35
Thuya plicata	8
Picea engelmanni	6
Tsuga mertensiana	3
Abies grandis	2
Species of Populus, Betula, etc	4

IV.—IN THE YELLOW-PINE ZONE.

Pinus ponderosa	10
Pseudotsuga taxifolia	70
Abies grandis	15
Species of Populus, Betula, Acer, Salix, and Amelanchier	5

Proportion of lumber trees of commercial size.

[By commercial size is understood a measurement of 16 inches and upward at the base.]

Pinus monticola	50
Larix occidentalis	41
Pseudotsuga taxifolia	5
Thuya plicata	2
Pinus ponderosa	1
Picea engelmanni	([1])
Tsuga mertensiana	([1])
Populus trichocarpa	([1])
P. balsamifera	([1])

SIZE AND AGE OF TREES.

Range in size and age of trees.

[By clear trunks is meant height to first branches of distinctive crown.]

I.—SUBALPINE ZONE, MATURE FOREST.[2]

Species.	Height.	Diameter.	Clear trunks.	Age.
	Feet.	*Feet.*	*Feet.*	*Years.*
Abies lasiocarpa	20 to 60	1 to 1½	10 to 25	40 to 100
Pinus albicaulis	20 to 50	1 to 3	0 to 20	50 to 200
Picea engelmanni	40 to 60	½ to 1½	0 to 30	30 to 90
Pinus murrayana	40 to 60	1 to 1½	20 to 25	100 to 150
Larix occidentalis	60 to 100	1 to 2	30 to 50	80 to 100
Pinus monticola	80 to 150	1 to 2½	30 to 60	50 to 120
Pseudotsuga taxifolia	30 to 100	1 to 4	0 to 60	50 to —
Populus tremuloides	20 to 25	⅓ to 1½	0	....

[1] Trifling.

[2] The larger heights and diameters are found near the lower limits of the zone; the smaller at altitudes above 5,500 feet.

FOREST NEAR PRIEST LAKE, SHOWING CEDAR TREES BARKED TO FURNISH THATCH FOR HUTS.

Range in size and age of trees—Continued.

II.—WHITE-PINE ZONE, OLD TO SECOND GROWTH.

Species.	Height.	Diameter.	Clear trunks.	Age.
	Feet.	*Feet.*	*Feet.*	*Years.*
Pinus monticola	150 to 250	2 to 5	80 to 120	200 to 375
Larix occidentalis	150 to 200	2 to 4	50 to 120	175 to 420
Pinus murrayana	60 to 100	$\frac{1}{3}$ to $1\frac{1}{2}$	20 to 60	30 to 90
Pseudotsuga taxifolia	80 to 150	$1\frac{1}{2}$ to $2\frac{1}{2}$	50 to 90	100 to 200
Thuya plicata	80 to 120	*a* 2 to $3\frac{1}{2}$	25 to 60	120 to 800
Picea engelmanni	80 to 100	$\frac{1}{2}$ to $1\frac{1}{2}$	0 to 30	50 to 120
Tsuga mertensiana	100 to 120	*b* $1\frac{1}{2}$ to 3	0 to 30	100 to 200 to 500
Abies grandis (*c*)	20 to 70	$\frac{3}{4}$ to 1	0	30 to 75
Betula papyracea	50 to 75	1 to 2	0	...
B. occidentalis	Small.	...	...	...
Populus tremuloides	20 to 40	$\frac{1}{2}$ to 1	10 to 20	...
P. trichocarpa	50 to 100	$1\frac{1}{2}$ to 3	20 to 40	...

a Rarely up to 8 feet. *b* Rarely up to 5 feet.
c Rarely 3 feet in diameter, with clear trunks 40 to 80 feet in height.

III.—YELLOW-PINE ZONE, MATURE FOREST.

Pinus ponderosa	50 to 90	$1\frac{1}{4}$ to 3	20 to 40	80 to 200
Pseudotsuga taxifola	50 to 100	$1\frac{1}{4}$ to 2	20 to 60	80 to 150
Abies grandis	...	Small.	...	...
Pinus murrayana	...	Small.	...	...

AREAS OF FOREST ZONES.

Areas occupied by each forest zone.

Zone.	Acres.	Per cent.
Yellow pine	60,000	10
White pine	480,000	80
Subalpine fir	60,000	10
Total	600,000	100

In estimating the areas of the different zones regard is had to the species of forest trees that grew on the various tracts before their deforestation by fires began about thirty years ago, and not to the present conditions of the burnt areas.

AMOUNT AND VALUE OF TIMBER.

Estimate of standing merchantable timber.

SAW TIMBER.

In the absence of surveys the various areas are computed from estimates as to the relative percentages that each bears to the total area embraced in the reserve, which is reckoned at 620,000 acres, exclusive of tracts permanently covered with water.

Acres.	Average per acre.	Total.
	Feet B. M.	*Feet B. M.*
134, 400	4, 000	537, 600, 000
60, 800	8, 000	486, 400, 000
28, 800	20, 000	576, 000, 000
3, 840	40, 000	153, 600, 000
150, 000	1, 000	150, 000, 000
377, 840	....	1, 903, 600, 000

In this estimate only trees having a diameter of 16 inches at the base are included, and only such species as are commonly sawed in this region, for enumeration of which see table on p. 245.

Living timber only is included in the above estimates. The amount of standing dead timber can not be computed even approximately. It varies from day to day, depending on the force and direction of the wind, on rain, snow, the degree of rot in the dead trunk and the position of the decay, together with the age of the burn, its location and exposure, the more or less complete burning of the humus, the character of the soil, and many other factors.

RAILROAD TIES.

Acres.	Average number per acre.	Total.
60, 800	296	17, 996, 800
134, 400	755	101, 472, 000
28, 800	100	2, 880, 000
3, 800	55	211, 200
160, 000	84	13, 440, 000
387, 800	....	136, 000, 000

This gives, at 20 feet per tie, a total of 2,720,000,000 feet B. M. Trees having diameters at the ground of 8 to 16 inches are considered tie timber. The following species are included in the list:

Pseudotsuga taxifolia.
Larix occidentalis.
Tsuga mertensiana.
Thuya plicata.

Estimate of standing merchantable timber—Continued

TELEGRAPH POLES.

Acres.	Average per acre.	Total.
20,000	30	600,000
150,000	10	1,500,000
170,000	....	2,100,000

This gives, at 100 feet per pole, a total of 210,000,000 feet B. M. The only species utilized for purposes of telegraph poles in this region is *Thuya plicata*, which is not abundantly represented in the forests of the reserve.

RECAPITULATION.

Kind of timber.	Feet B. M.
Saw timber	1,903,600,000
Railroad ties	2,720,000,000
Telegraph poles	210,000,000
Total	4,833,600,000

Estimated value on root of standing timber.

Kind of timber.	Amount.	Average stumpage value.	Total value.
Saw logs .... M. feet..	1,903,600	$0.50	$951,800
Ties .... number..	136,000,000	.02	2,720,000
Poles .... do....	2,100,000	.05	105,000
Total	....	....	3,776,800

Approximate value of timber when ready for consumption at first point of manufacture.

Kind of timber.	Amount.	Average value.	Total value.
Saw logs .... M. feet..	1,903,600	$10.00	$19,036,000
Ties .... number..	136,000,000	.20	27,200,000
Poles .... do....	2,100,000	.25	525,000
Total	....	....	46,761,000

Living timber only is included in above estimates. Dead timber there has no commercial value.

DESTRUCTION BY FIRES.

Estimate of merchantable timber consumed by forest fires in the last thirty years.

SAW TIMBER.

Acres.	Average per acre.	Total destroyed.
	Feet B. M.	*Feet B. M.*
134,400	1,000	134,400,000
60,800	800	48,640,000
28,800	200	5,760,000
3,840		
100,000	20,000	2,000,000,000
50,000	30,000	1,500,000,000
160,000	5,000	800,000,000
537,840		4,488,800,000

RAILROAD TIES.

	Number.	Number.
50,000		
100,000	30	3,000,000
120,000	100	12,000,000
250,000	800	200,000,000
20,000	1,500	30,000,000
540,000		245,000,000

TELEGRAPH POLES.

200,000	30	6,000,000

Estimated value of timber burned.

4,488,800,000 feet, at 50 cents per thousand	$2,244,400
245,000,000 ties, at 2 cents per tie	4,900,000
6,000,000 telegraph poles, at 5 cents per pole	300,000
Value of young growth during thirty years	1,500,000
	8,944,400
Less 5 per cent depreciation caused by windfalls, rot, etc., during thirty years	447,220
Total	8,497,180

Approximate value of timber burned at first point of manufacture.

4,488,800,000 feet saw logs, at $10 per thousand feet	$44,888,000
245,000,000 ties, at 20 cents per tie	49,000,000
6,000,000 telegraph poles, at 25 cents per pole	1,500,000
Value of young growth during thirty years	15,000,000
	110,388,000
Less depreciation in value during thirty years caused by rot, windfalls, etc	4,447,220
Total	105,940,780

SUMMARY.

Estimate of available sound timber.

	Feet.
Total amount of standing merchantable timber	4,833,600,000
Young growth less than 110 years old, from 8 to 16 inches in diameter, about 65 per cent, or	3,141,840,000
Second and old growths over 110 years old and 16 inches in diameter, about 35 per cent, or	1,691,760,000
Total	4,833,600,000
Solid young growth, about 40 per cent, or	1,256,736,000
Young growth mixed with old and second growths, about 60 per cent, or	1,885,104,000
Total young growth	3,141,840,000
Accessible solid young growth, about 60 per cent, or	754,041,600
Accessible young growth mixed with second and old growths, about 70 per cent, or	1,319,572,800
Accessible young growth	2,073,614,400
Accessible old and second growths, about 80 per cent, or	1,353,408,000
Total accessible timber, about 70.9 per cent, or	3,427,022,400

Amounts that may be safely cut from the accessible places with due regard to the strength of the forest,

	Feet.
Young growth:	
Of solid growth, about 50 per cent, or	377,020,800
In mixed old and second growths	none.
Total young growth	377,020,800
Old and second growths:	
Of old growth, reckoned at 20 per cent, about 80 per cent, or	270,681,600
Of second growth, reckoned at 80 per cent, about 30 per cent, or.	406,022,400
Total old and second growths	676,704,000
Total available merchantable timber	1,053,724,800

Cord wood and fencing material are excluded from above estimates. Fencing material is an uncertain factor and cord wood has no other value in the reserve than the labor expended upon it.

Agricultural lands.

	Acres.
Fork of Upper Priest River (Gold Creek)	300
North end of Upper Priest Lake	280
North end of Lower Priest Lake	200
Upper Granite Creek	500
Reeder Creek	1,030
Kalispel Creek	100
Bear Creek	350
Soldier Creek	200
Medly Creek	140
South end of Priest Lake	250
Junction of East and Priest rivers	425
Big Creek	160

	Acres.
Lower Priest River above rapids	300
Long Creek (Blue Creek)	250
East Pine Creek	50
Lower West Branch of Priest River, including swampy country between the heads of West Branch, Benars, Lamb, and Granite creeks	3,380
Pend Oreille Valley	1,200
Small creeks (no names)	375
Narrow strips of alder swamps along small creeks, beaver ponds, drainable lakelets, and cranberry bogs	500
Total	9,990

These areas comprise land more valuable for agricultural than for forestry purposes.

BITTERROOT FOREST RESERVE.

By John B. Leiberg.

The Bitterroot Forest Reserve, situated partly in the State of Montana and partly in the State of Idaho, is divided into two unequal parts, an east and a west part, by the Bitterroot Range of mountains. The eastern section lies wholly within the basin of the Bitterroot River, in Montana; the western portion forms in part the watershed of the Clearwater, and in part that of Salmon River, in Idaho. The two sections are dissimilar both in topographic and in forestry features, and will therefore be treated separately, the latter portion in a later report.

Owing to the great area of the reserve and the limited time available, only a comparatively small section was examined. The portion traversed included, in Montana, the Bitterroot Valley within the reserve limits, except a small tract of approximately 40 square miles north of Big Hole Pass and a section of the high summits of the main range of the Bitterroot from St. Mark Peak southward about 20 miles. In Idaho the area examined included the summits of the main range for a distance of about 50 miles in length and from 5 to 8 miles in width, from the Salmon River Pass at Mineral Hill at the head of the South Fork of the Bitterroot to the head of Blodgett Canyon, and the tributaries and main canyon of Bear Creek to its junction with Magruder Fork of the Middle Fork of the Clearwater, together with a section about 20 miles in length and 8 to 10 miles in width along the latter stream; in all, about 1,650 square miles, of which 650 square miles were in the Clearwater basins and 1,000 in the valley of the Bitterroot.

In addition to the above there was examined a tract about 25 miles long and 6 miles wide in the heavily timbered portions of the main Bitterroot Valley outside the reserve, from Roaring Lion Creek to the entrance of Trapper Creek into the West Fork of the Bitterroot.

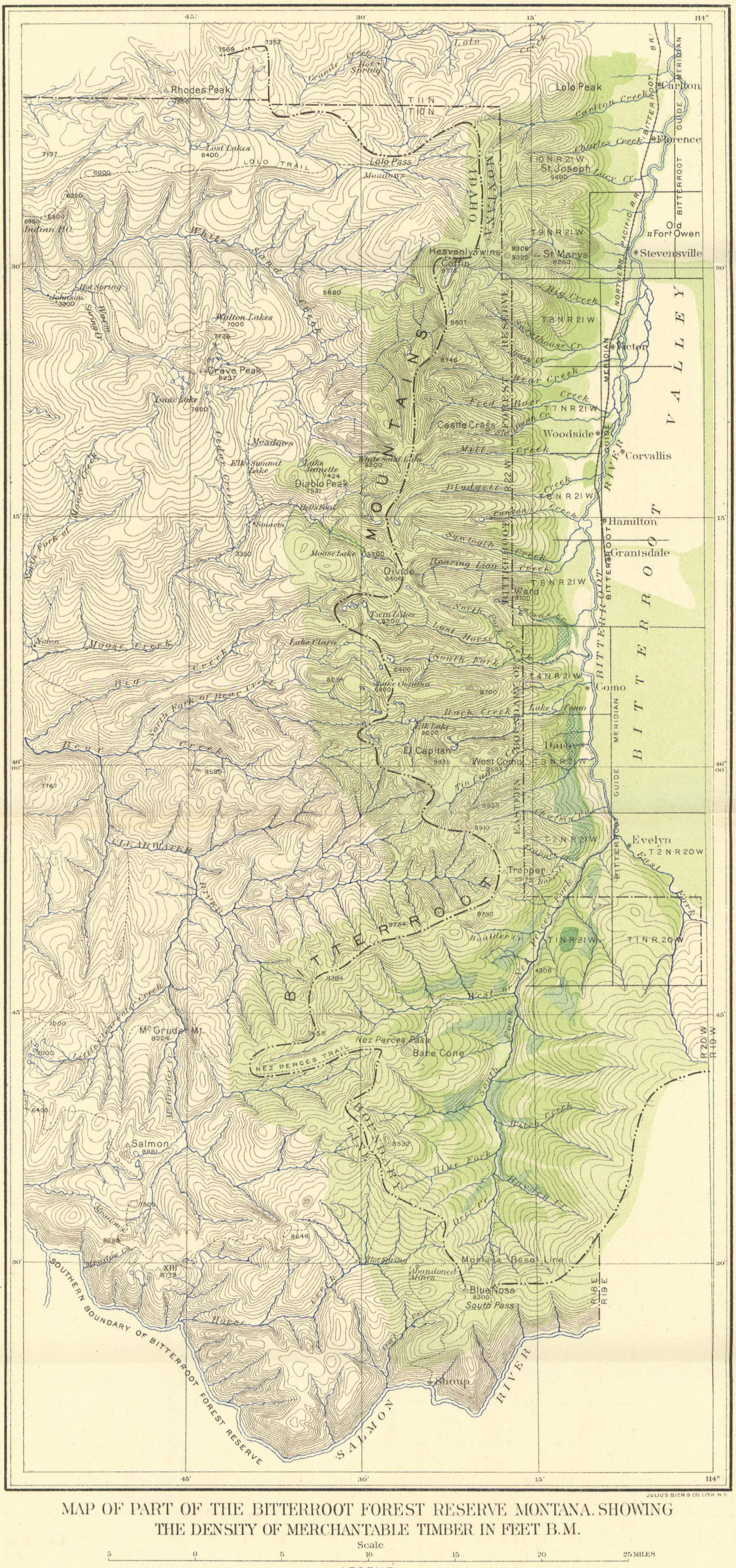
EASTERN PORTION: THE BITTERROOT RIVER BASIN.

TOPOGRAPHY.

The Bitterroot Valley is a depression sloping northward, separating the Rocky Mountains from the Bitterroot Range for a distance of 105 miles. It is drained by Bitterroot River and its numerous affluents, whose ultimate heads lie partly in the Rocky Mountains and partly in the Bitterroots. Near the city of Missoula the river forms a junction with other streams coming from the east, and flows thence northward under the name of Missoula River to its outlet in the Clarks Fork of the Columbia. About 6 miles south from the point where the Bitterroot River loses its identity in the Missoula it receives its first large affluent, the Lolo Fork, a stream which heads in the Bitterroot Range on the northern slopes of St. Mary Peak. Thence southward for a distance of about 62 miles numerous tributaries enter the river, mostly from the west. They are nearly all small, though in the aggregate their volume of water is considerable. About 9 miles south from the village of Darby, or 68 miles from its junction with the Missoula, the Bitterroot River divides into two large forks, the East and the West forks. The East Fork, as to its principal stream, lies outside the reserve, with the exception of a small portion of the crest of the ridge along its western watershed. It heads in the Rocky Mountains and has a greater length than the West Fork. The latter stream continues from the junction of the two forks for a distance of 11 miles westerly, when it again forks, one branch, the longer one, known as the South Fork, coming from the south, and the other, the smaller branch, entering from the west under the name of the Little West Fork. About 5 miles above the junction of the Little West Fork with the South Fork the former stream again splits up into two principal branches. The more southern is named the Little South Fork, while the northern is considered the principal stream and retains the name Little West Fork.

The main valley of the Bitterroot from its junction with the Missoula River to a point 1½ miles south from the town of Grantsdale has a width of about 10 miles from the foot of Bitterroot spurs on the west side of the river to the upper terraces on the eastern slope, which has a gradual ascent and no sharp line of demarcation between the topmost terrace and the final rise to the summit of the divide. Beginning near Grantsdale, and thence to the junction of the East Fork and the West Fork, the valley contracts to a width of between 5 and 6 miles, with the eastern declivities more abrupt, a line of bluffs rising sharply from the valley to the direct slopes of the inclosing mountains, without any well-defined intermediate terraces. The valleys of the West Fork, the South Fork, the Little South Fork, and the Little West Fork are mere narrow troughs, varying at their bottoms from one-third to one-half mile in width and with well-defined terraces only along the lower 6 miles of the West Fork. Occasionally, especially in the South Fork Valley, the troughs contract and form short gorges.

The eastern and the western watersheds that form the basin of the Bitterroot are somewhat unequal in areal extent, the eastern being the larger. It, however, supplies a great deal less water to the volume in the river, owing to its greater aridity. We estimate that about four-fifths of the quantity of water discharged into the Missoula River from the Bitterroot is drained from the western watershed.



JULIUS BIEN & CO. LITH. N.Y.

MAP OF PART OF THE BITTERROOT FOREST RESERVE MONTANA, SHOWING THE DENSITY OF MERCHANTABLE TIMBER IN FEET B.M.

Scale

5 0 5 10 15 20 25 MILES

LEGEND

LESS THAN 2,000 FEET
2,000 TO 5,000 FEET
5,000 TO 10,000 FEET
10,000 TO 20,000 FEET
30,000 TO 45,000 FEET

SKETCH CONTOURS

1898.

The areas of the Bitterroot drainage basin that are situated within the boundaries of the forest reserve are confined to the western portions. From St. Mary Peak, at the northeast corner of the reserve, to a point due west from the junction of the West and East forks, about four-fifths of the western watershed, exclusive of the valley trough, is within the reserve limits. The upper half of the West Fork and the entire basins of the South Fork, the Little South Fork, and the Little West Fork valleys, with a small area of the watershed of the East Fork of the Bitterroot just north from Bighole Pass, are also included within the reserve area. The aggregates of the various tracts within the watershed of the Bitterroot River covered by the reserve are approximately as follows:

	Square miles.
Main Bitterroot Valley from St. Mary Peak to a point opposite junction of East and West forks	400
Upper portion of West Fork Basin	95
Little West Fork Basin	155
Little South Fork Basin	90
South Fork Basin	470
East Fork Basin	20
Total	1,230

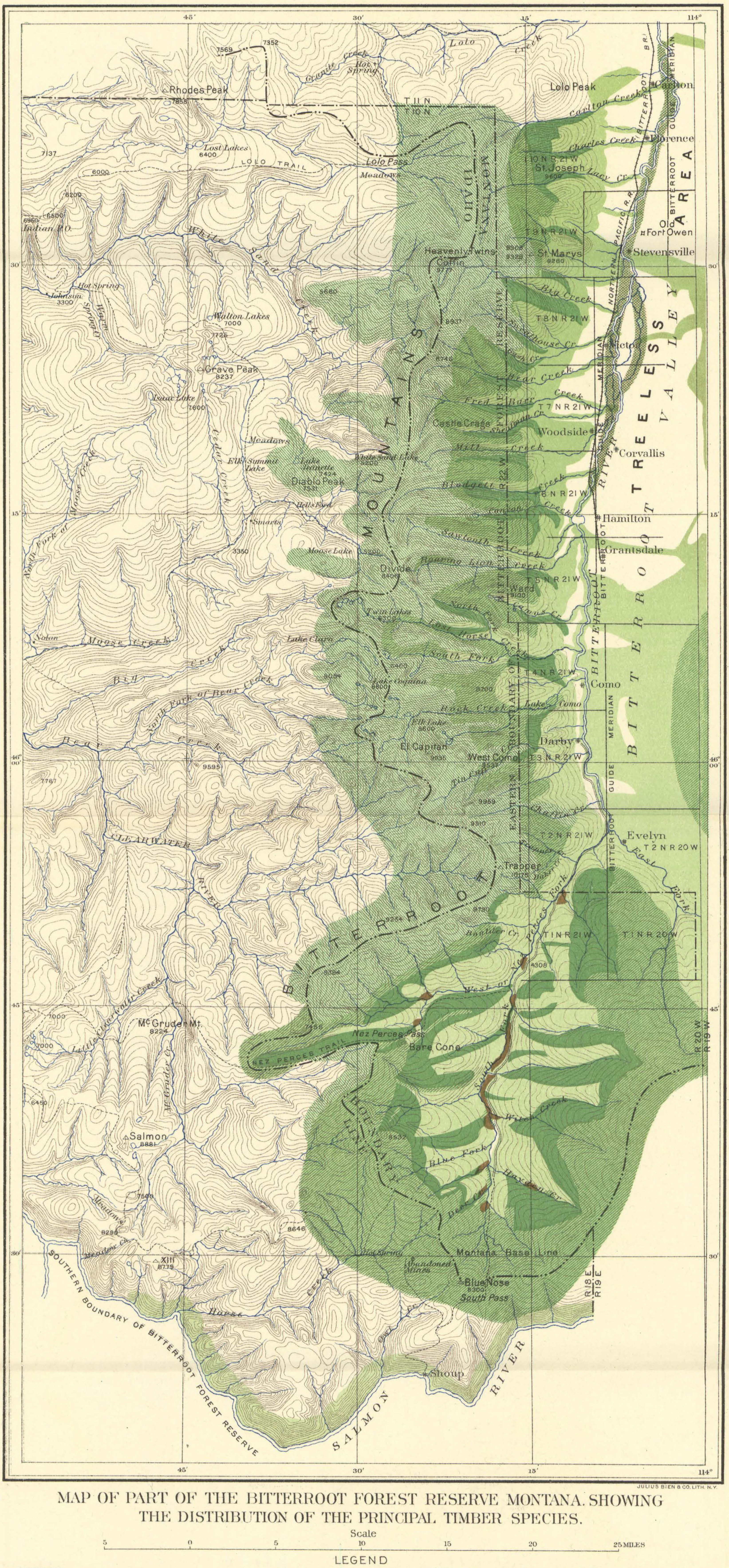
This gives a total equivalent to 787,200 acres.

The western summit of the Bitterroot watershed is formed by the crest of the main Bitterroot Range of mountains, lying 8 to 15 miles west of the valley trough. The range rises abruptly from the valley level, with no intermediate foothill region. It is cut at frequent intervals by long, nearly straight, bowlder-obstructed canyons that extend to the main backbone of the range. The ridges between the canyons are steep, rocky divides, usually with peaked and saw-toothed crest lines, presenting bold fronts to the main valley and inclosing the side canyons with high, often precipitous, walls in many localities, without soil or vegetation, and with slopes covered by masses of slidden rock. These features are constant from St. Mary Peak, at the northeast corner of the reserve, to the head of Little West Fork. Owing to a change in the rock formation here, the spurs and ridges assume a different aspect. The gulches are shorter, the hill slopes are less steep, more rounded, with broader crest lines, and lack the masses of slidden rock and numerous precipices that characterize the range farther north. The crest of the main divide north of the head of the Little West Fork is exceedingly rocky and tortuous. Like its eastern spurs, it abounds in precipices, rock slides, and rugged peaks, with but a very sparse growth of vegetation, and is often wholly bare. By reason of its generally greater height these features are of larger proportions than is the case with the side spurs. At intervals it is pierced with passes affording egress from the east to the west or vice versa. The passes are low saddles in the ridge where two or more streams head and flow in opposite directions, and are found at the head of nearly all the larger canyons. The summit of the ridge varies in altitude from 6,000 feet in the saddles to 10,000 feet above sea level on the highest peaks. The greatest elevations are St. Mary Peak, in the northern portion, and El Capitan, or Gunsight Peak, in the central region of the range. The altitude of the former is approximately 9,900 feet and of the latter 10,100 feet above sea level. The summit line is not continuously passable for pack animals, nor for men on foot, owing to its rocky and precipitous nature. South from the head of the Little West Fork the divide is lower, seldom rising above 7,000 feet above sea level. It is also much broader along its crest line, is less winding and tortuous, and can be traveled with comparative ease.

The slopes that form the eastern watershed of the Bitterroot Basin rise with a low angle and more or less terraced sides for the first 55 miles southward. Above Skalkaho Creek, near Grantsdale, the slope becomes much steeper. The crest line lies about 30 miles east of the valley, but as a continuous ridge is scarcely so definite and well marked as the summit of the western watershed. The ultimate divide is the main range of the Rocky Mountains, but the intermediary ranges, radiating in all directions, form so many separate divides that the central backbone, which only touches the valley near its southern extremity, is lost sight of. The canyons that enter the valley from the east are not so numerous nor so regularly arranged as are the western affluents. The divides between them rise from the valley with easy gradients, presenting fronts many miles in width that are seamed and scarred with shallow, steep, and irregular gulches, sometimes cutting back several miles in the fronting portion of the spur.

The divide between the two principal forks of the river—the East and the West, with the South Fork extension of the latter—is a northward-projecting spur originating at the topographical point of junction of the Bitterroot and Rocky mountains. In its general arrangement of canyons and slopes it resembles the eastern watershed of the basin above Grantsdale, but has a rocky crest line, and the summit slopes are bestrewed with numerous bowlder slides.

Aside from its varying width the valley of the Bitterroot throughout its length presents one general aspect, merely modified here and there to a greater or less extent by ordinary river erosion. Like many of the valleys constituting the Columbia River watershed, it appears to have been at one time a depression holding a lake, or, rather, an arm of a much larger lake lying to the northward which covered to a large extent the present head of Clarks Fork of the Columbia River Basin. A vast mass of transported material—sand, gravel, and large and small bowlders—was deposited over the bottom of the Bitterroot Lake. Glacial action, especially in the Bitterroot Range, was an active factor in bringing down this débris and in cutting out the remarkable canyons that seam the slopes of the western watershed. The existence of the lake was probably due to a blocking of the valley trough of Clarks Fork by ice masses sliding into it from the adjacent mountains. When the glacial barriers were removed, drainage of



MAP OF PART OF THE BITTERROOT FOREST RESERVE MONTANA, SHOWING THE DISTRIBUTION OF THE PRINCIPAL TIMBER SPECIES.

Scale

5 0 5 10 15 20 25 MILES

LEGEND

- POPLARS (Populus balsamifera P. tremuloides), WITH SOME YELLOW PINE (Pinus ponderosa) AND WILLOWS
- YELLOW PINE (Pinus ponderosa), 70% AND OVER
- RED FIR (Pseudotsuga taxifolia), 80% AND OVER
- SUBALPINE AREAS SPARSELY COVERED WITH VARYING PROPORTIONS OF SUBALPINE FIR (Abies lasiocarpa), WHITE BARK PINE (Pinus albicaulis), LYALL LARCH (Larix lyallii), ENGELMANN SPRUCE (Picea engelmanni), AND LODGEPOLE PINE
- LODGEPOLE PINE (Pinus murrayana), NEARLY PURE GROWTH
- AGRICULTURAL LANDS WITHIN THE RESERVE

SKETCH CONTOURS

1898.

the lake occurred. Since then the stream has cut into, and in some places through, the superficial deposits of gravel and bowlders, and while doing so has shifted its flood plain back and forth across the valley. The result is a succession of benches in the wide portions of the valley, and in the lowest, or flood terrace, a large number of closed bayous or abandoned channels. Some of these old channels have in process of time been filled with deposits of loam and mold and are good meadow and agricultural lands; others are areas of springs and mud or semi-stagnant water; still others are filled with masses of liquid ooze covered with close and tough turf, to which the mere pressure of a human footstep imparts an undulatory movement, but which nevertheless possess sufficient tenacity to sustain the weight of grazing animals.

GEOLOGY.

The Bitterroot Range from the north line of the reserve to the head of the Little West Fork is composed exclusively of various modifications of granite rocks. The eastward-projecting spurs are in general of similar composition. Some small areas of gneissoid rocks occur on the eastern slopes of St. Mary Peak and from this point for a few miles southward near the valley level. The granites are extremely hard, but nevertheless much and deeply fissured in all directions. South from the head of the Little West Fork the rock formation undergoes an entire change. The granites are replaced by great masses of quartzites and felsitic rocks, extensively diked by intrusions of andesite, trachyte, rhyolite, diorite, and the like. The change is very abrupt, and owing to the softer texture of these rocks as compared to the granites of the main range farther northward, we have the general lowering of the topographical asperities already alluded to. Considered from a geological standpoint the Bitterroot Range and the Rocky Mountains coalesce where the geological formations change, and not where the topographical union is indicated. The character of the rocks and their age from Bighole Pass to the head of the Little West Fork ally them with the geology of the Rocky Mountains in this region and not with the Bitterroots. As a sequence to the view here advanced the section of main divide between the two points designated above is in reality merely a northward-projecting spur from the Rocky Mountains. The rocks of the basins of the Little South Fork and the South Fork also belong to the Rocky Mountain formation.

WATER SUPPLY AND ITS UTILIZATION.

Throughout its entire extent, below elevations of 5,000 feet above sea level, the valley of the Bitterroot must be classed as an arid region so far as agricultural operations are concerned, notwithstanding the fact that large areas below this height support a heavy growth of forest. However, as soon as the timber is cleared away and tillage of the ground commences aridity is the consequence, and artificially supplied moisture becomes necessary to the production of crops. The only areas where an exception to this rule occurs are the filled-in bayous or old river channels in the present flood terrace. There are varying degrees of aridity as between the different sections of the valley. The northern portion is most conspicuous in this respect, and of the two halves the section east of the river is much the drier. The proximity of the high main range of the Bitterroot is the chief cause of the lessened humidity in the valley to the east. Precipitation comes principally from the south and southwest, and the range stands in the way of free circulation of air. It intercepts the greater portion of the humidity, compelling condensation and precipitation along its crest and summit slopes, and permits but a fraction to pass over into the valley. The precipitation on the range and its spurs occurs mostly as snow. No reliable data are obtainable regarding the greatest depth of the winter's accumulation. The statements of persons that have crossed the main divides in early spring, when we may assume the greatest depth, are conflicting. It would appear, however, that it is not less than 12 feet for the divide between St. Mary Peak and the head of the Little West Fork at elevations of 6,000 feet above sea level, nor less than 5 feet from the head of the above-mentioned stream to Bighole Pass. How large a quantity of water in inches this represents is not known. The aspect of the timber growth at elevations of 6,000 feet, as compared with forests composed of similar species where the yearly precipitation is approximately known, would indicate about 60 to 65 inches as the average for the year along the main divide north of the head of the Little West Fork, and from 35 to 40 inches for the section south to Bighole Pass. Precipitation in the valley is probably nearly equally divided between rain and snow. About 10 to 15 inches of water is the average for the northern portion of the valley. More falls in the southern areas, but never enough to suffice for the production of crops. Although reaching considerable elevations, there is no universal snow line on the Bitterroot Range. There is one on the east and north slopes on peaks above 8,000 feet elevation, but, in general, by far the greater portion of the winter snows melts between late spring and the ensuing fall. Owing to direction of exposure, longer slope, and less precipitation, the eastern watershed has no permanent snow line in any direction.

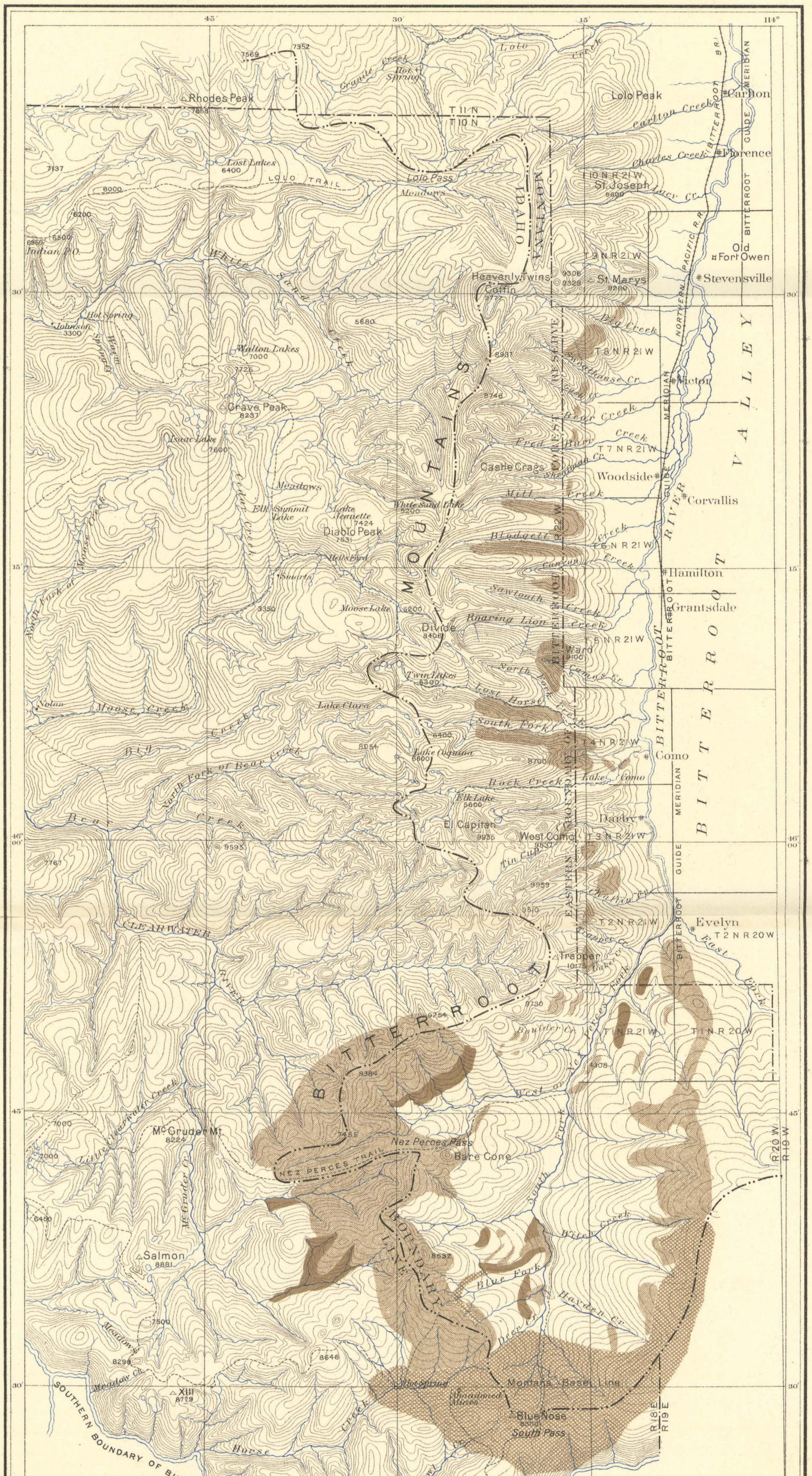
The equalizing factors in the distribution of the season's precipitation from the western watershed of the basin are as follows:

(1) The topographical configuration around the head of the main-range canyons and their smaller laterals.

(2) The amount of fissuring that the rocks along the canyons and at their heads have been subjected to.

(3) The rapidity with which the snow is melted and the resultant discharge of water into the streams.

(4) The rapidity of the flow from the higher to the lower levels.



MAP OF PART OF THE BITTERROOT FOREST RESERVE MONTANA. SHOWING EXTENT OF BURNED AREAS WITHIN THE LAST 35 YEARS.

Scale

5 0 5 10 15 20 25 MILES

LEGEND

AREA BURNED NEARLY TOTAL, AND WITH NO YOUNG GROWTH

AREA BURNED NEARLY TOTAL, BUT NOW COVERED WITH YOUNG GROWTH OF LODGEPOLE PINE PRINCIPALLY

AREA BURNED ABOUT 50%, WITH SPARSE YOUNG GROWTH OF LODGEPOLE PINE AND RED FIR

SKETCH CONTOURS

1898.

The topographical features at the head of the canyons originating in the main range present two aspects. In the granite portion they have usually as their ultimate heads flat, marshy expanses, or small lakes excavated in the main divide, in the larger spurs, or in both. The marshy tracts usually hold one or more lakelets, which in the past were much larger, but have been gradually reduced by the wearing away of the rock barriers at the outlets. They are covered with a close, thick turf of alpine grasses and sedges, and often have small copses of trees scattered over their areas. Where forest fires have not penetrated they are surrounded with a dense fringe of the subalpine forest. Along the margin where the fringe of forest joins the grassy area is the spring level. Innumerable springs issue along this margin, discharge into the lakelet of the basin, and assist in maintaining the stage of water in the stream whose head they form. The springs represent the seepage from the surrounding heights. Sometimes the lake or pond has been drained by the complete wearing away of the outlet barrier, the springs discharging into one or more sluggish streams that meander through the meadow. Sometimes, but rarely, the meadow is lacking, and the springs issue into a lakelet situated in a hollow scooped out in the naked granite. Marshy tracts and lakelets similar to those described are sometimes found, not only at the heads, but also in the middle and upper portions of the canyons. All these areas form a natural reservoir system which is one of the main regulators in the flow of water from the Bitterroot canyons, and as such is of the greatest importance. The lakelets and marshy expanses are lacking in the portion of the watershed south of the head of the Little West Fork. Other factors of the four we have indicated are there present, however, in greater force, and make up for the deficiency of the other.

On the amount of rock fissuring depends the quantity of water that will sink upon the higher slopes within a given time and issue at lower levels as springs. The rocks of the granite areas of the Bitterroots are extensively and deeply shattered, and the slopes are widely littered with rock slides composed of bowlders, large and small, the interstices more or less filled with coarse gravel, sand, or clay. The rock slides are good conservators of the water flow, and supply largely the natural deficiency in the subalpine forest growth which exists in the higher regions. Beyond the granite areas in the upper portion of the Bitterroot Basin the fissuring and the rock slides have not been so extensive. The dikes of eruptive matter have, however, shattered the solidity of the adjacent bed rock in various localities and created underground waterways from which feeders issue that assist in maintaining the water level in the streams.

Considering the elevation at which it lies, the snow in the Bitterroot Range melts rapidly. The large areas along the upper slopes devoid of forest give the sun and wind free access, and the numerous precipices upon whose sides no snow can lodge reflect the sun's heat on the snow banks that adjoin them and hasten the melting process. Were the bed rock less fissured, or did not the basin reservoirs exist, vast quantities of water from the rapidly melting snows would be suddenly precipitated every spring into the valley below, bringing with it the débris of bowlders and sand torn out and ground down from the mountains. The fall throughout the canyons of the granite sections of the Bitterroots is very considerable, amounting in many cases to 300 or 400 feet a mile, and for short distances even more. It is not uniform, however, being interrupted at various points by flat, marshy tracts. The torrential force of the water capable of being engendered by such rapid descents is largely counteracted by the vast bowlder accumulations in the stream beds. Yet, if the water-retarding influences along the canyons and at their heads were interfered with to any great extent, there is scarcely a doubt that the spring volume of water would be sufficient to sweep the bowlder masses into the main valley.

The factors that control the water distribution through the canyons of the Bitterroot Basin south of the Little West Fork are an abundance of forest growth and slight fall in the streams. The former is the more potent, as it prevents too free circulation of warm air and screens the snow banks from the direct rays of the sun and too rapid melting. In this section there is also much less precipitation than on the watershed farther northward.

The canyon system of the western watershed is remarkable in the paucity of laterals received by the main streams. The explanation is found in the short transverse basal diameters of the dividing spurs, which make impossible the existence of long side canyons. Instead each canyon from its point of discharge into the main stream to its head in the Bitterroot Range is a sort of fairly regular and straight sluice box, receiving but a few short affluents from each side, but dividing near its head into several branches. In the range north of the Little West Fork these branches are often of considerable length, made possible by the great westward retreating angles of the main divide.

The volume of water in the main Bitterroot River is almost wholly dependent on its canyon affluents, and varies accordingly. The only accessions from other sources, rain and snow in the valley trough excepted, come from the springs that burst out along the terrace slopes at various points. They are numerous at certain places, as between Roaring Lion and Lost Horse creeks, and less common farther south. Some are quite circumscribed, while others cover areas of 15 to 30 acres, and give rise to small creeks, that occasionally carry a sufficient volume of water to make them valuable for irrigation purposes. The springs owe their origin to the accumulated drainage that flows from the front of the mountain spurs abutting on the valley. In its downward flow to the main river through the mass of glacial detritus, hidden obstructions, such as ledges of rocks or impermeable beds of

BITTERROOT VALLEY NEAR GRANTSDALE, LOOKING WEST.

clay, are encountered, the water is forced to the surface, and springs result.

For purposes of irrigation water is taken from the main river and from the lateral tributaries. Only a fraction of the volume in the main stream is utilized at present. The terraced formation of the valley offers great obstacles to extensive irrigation by means of water taken from the river. The upper terraces below the main forks are elevated from 300 to 700 feet above the flood level, and to reach them with water from the main river would require the construction of miles of expensive ditches from near the ultimate heads of the streams. Most of the lands in the Bitterroot Valley are irrigated by water taken from the side canyons. The volume carried by them during the growing season is wholly insufficient to meet the possible demands, and in consequence large tracts of arable land are untilled. Nearly all the canyons of the western watershed offer good opportunities for the creation of small storage reservoirs. There are no physical difficulties in the way of constructing retaining dams at the head of the streams and turning the subalpine meadows into lakes. Many localities along the central portion of the canyons between the stretches of rapid descent present similar opportunities for easy damming of the streams, and most of them are narrow enough at their point of debouchure into the main valley to afford possibilities for the erection of storage dams to hold back limited quantities of water.

West of Como post-office, at the mouth of Rock Creek, Como Lake forms a natural storage basin. By a dam at its outlet this could be readily enlarged to several times its present volume.

Dams to hold back a portion of the surplus water have been constructed in Mill and Big creeks, two streams heading in the Bitterroot Range. Their construction, which is on a small scale, has been a matter of local enterprise. So far as it goes the work has been entirely successful. The enlargement of the irrigated area in the western half of the Bitterroot Valley will unquestionably depend upon the conservation of water that now originates in and flows from the watershed within the reserve limits. The heads of these streams lie at such a height and the fall is so rapid that, given a sufficient volume of water, even the highest terraces can be reached by means of comparatively short ditches. The eastern side of the valley is not so favorably situated for irrigation from the lateral affluents of the Bitterroot. The long slope has facilitated the excavation of deep gully-like channels through all but the lower terrace, and in addition, owing to a diminished precipitation, many of the streams are mere dry runs during the growing season.

There are no data obtainable regarding the volume of water discharged by the Bitterroot into the Missoula River. Its volume varies much in different sections along its course. There is evidently an enormous underflow through the loose and porous subsoil, and the abandoned and partially filled bayous absorb large quantities, thereby setting up an extensive side flow.

The current in the main river, on the average, is rapid, but is far from uniform. It varies from one-half mile in short, slack-water spots to 4 or 5 miles an hour, or even more on the ripples. The aggregate amount of fall from the upper portion of the South Fork to the point where the river discharges into the Missoula is about 1,600 feet and from the summit at the head of the same fork about 2,800 feet.

SOIL CONDITIONS.

The surface soil of the valley is of a light sandy or gravelly composition in some localities, especially on the east side of the river, and on the flood terrace it is more or less mixed with clay. The subsoil is composed almost wholly of sand, gravel, and bowlders, rarely of beds of clay. On top of this subsoil rests a layer of loam and mold from 1 to 2 or more feet in thickness. The flood terrace has the deepest soil, as it is largely made up of old river channels which have been filled with thick deposits of vegetable débris. The upper benches possess the lightest soils. Bowlder-strewn tracts covering from 50 to 1,000 acres are met on both the upper and the lower terraces throughout the entire extent of the valley. The soil of the mountain slopes is merely a thin layer of mold resting on coarse granite detritus. The bottoms of the canyons are exactly similar, but have a heavier covering of topsoil, due to the washing in from the slopes above. The subalpine meadows have a subsoil of purely granite gravel, with the mold and loam varying from 6 inches to 6 feet or more in depth. The greatest accumulations occur in sphagnous bogs that are common around the margins of the lakelets in those meadows.

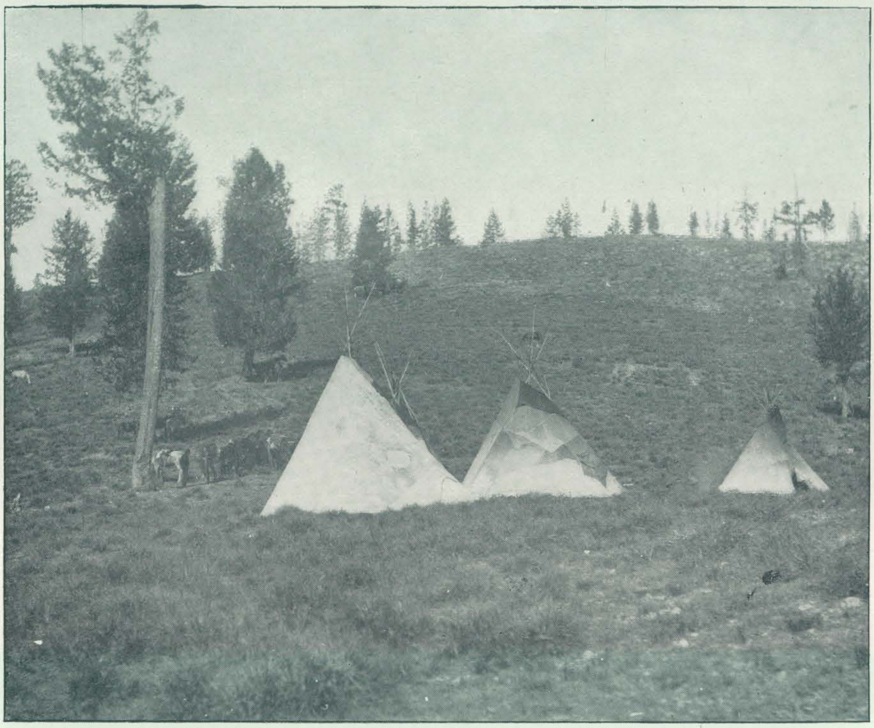
AGRICULTURAL LANDS.

The agricultural lands in the Bitterroot Valley below the main forks are, in effect, all lands upon which water can be brought. Within the reserve limits there are no agricultural lands from St. Mary Peak, at or near the northeast corner of the reserve, to the point where the east boundary line crosses the West Fork, near Bowlder Creek. The entire area between the east boundary line and the summit of the Bitterroot Range is a mass of rugged, sharp peaks, saw-tooth crested spurs and ridges, steep or perpendicular mountain slopes, and rocky, bowlder-obstructed canyons.

The agricultural lands within the reserve limits are situated in the valleys of the South Fork, Little South Fork, Little West Fork, and West Fork, and are of two kinds:

1. Tracts on which the timber has long been cut and which are now under the plow.

2. Areas along the streams, covered with a growth of brush, willows, or coarse sedges, and having occasional small patches under the plow.



A. SUMMIT OF THE BITTERROOT RANGE AT NEZ PERCES PASS.

B. MAIN RANGE OF THE BITTERROOT MOUNTAINS, LOOKING NORTH FROM NEZ PERCES PASS.

A. SUMMIT OF THE BITTERROOT RANGE NORTH OF LOST HORSE PASS, SEEN FROM BIG SLIDE IN LOST HORSE CANYON.

B. SUMMIT OF BITTERROOT RANGE, LOOKING SOUTH FROM NEZ PERCES PASS; CROWN PEAK IN THE NEAR BACKGROUND.

Lands of class 1 are found in the Little West Fork and West Fork valleys. The amounts are as follows:

	Acres.
Little West Fork at its junction with South Fork	45
Near Prickett Creek, West Fork Valley	10
Total	55

These holdings are included in three squatter claims, with an aggregate of 480 acres. Hay is the principal crop obtained from the tracts under cultivation. Besides these claims, on which a fairly constant residence is maintained, there are a great many others marked only by dilapidated cabins and decaying fences. They were originally taken as squatter claims, and were abandoned as soon as the timber growing on them was cut and disposed of. In only a single instance is present residence maintained on any of them, namely, at the junction of South Fork and Little West Fork. No portion of this claim, however, is under the plow.

The lands in class 2 are situated in the valleys of the Little South Fork and the main South Fork. Their approximate distribution is as follows:

	Acres.
In the upper half of Little South Fork Valley	200
In South Fork Valley below and including Rambo Flat	150
In South Fork Valley from Slate Creek to Overwhich	250
In South Fork Valley between Overwhich and Hughes Creek	150
In Overwhich Valley	120
In Hughes Creek Valley	350
In Wood and Chicken creeks	100
In South Fork Valley at Mineral Point	120
Total	1,440

Of this, the amount under cultivation is approximately as follows:

	Acres.
In the valley of Little South Fork	...
In the valley of main South Fork	...
Below Overwhich	5
At Overwhich	20
Above Overwhich	2
Total	27

The agricultural lands of class 2 are nearly all occupied by parties maintaining a residence on their several claims. About 12 holdings, embracing 1,920 acres, cover the lands of this class. Owing to lack of surveys the claims have no legal boundaries, and their sides and end lines as staked out do not form right angles, but pursue zigzag courses following the valley contours and excluding the hillsides.

The aggregates of the agricultural lands within the reserve in the Bitterroot Basin are therefore as follows:

	Acres.
Little West Fork and main West Fork basins	55
Little South Fork and main South Fork basins	1,440
Total	1,495

Land actually under cultivation:

	Acres.
Little West Fork and main West Fork basins	55
Main South Fork and Little South Fork basins	27
Total	82

The valley troughs of the South Fork and Little West Fork have two low terraces. They are not continuous and are found principally in the lower half of their valleys. The agricultural claims lie on the lower terrace. The upper is always rocky or littered with drift bowlders, and is not suitable for agricultural operations. The valleys in which these lands lie are frosty. They are above the 4,000-foot level and, receiving the cold draft from the great canyons that open up to the main divides every 2 or 3 miles, are liable to a freeze at night any time during the growing season. The small area under cultivation is mostly seeded to timothy, a few very limited patches producing an uncertain and inferior crop of potatoes and the hardiest common vegetables.

GRAZING LANDS.

The hillsides adjacent to the valleys of the Bitterroot Basin above the main forks are utilized to some extent as grazing grounds. The southern and western slopes below 5,200 feet elevation usually produce an open growth of timber, with the ground covered by a sward of grasses and sedges. Cattle and horses are pastured there, but no sheep. Most of the stock is owned by parties that live outside the boundaries of the reserve, chiefly in the Bitterroot Valley, below the junction of the East Fork and the West Fork, where the natural grazing is largely eaten out. No appreciable damage appears to be done by the grazing in the forest.

The proposition has been advanced by parties living in the Bitterroot Valley that the subalpine meadows at the head of the streams in the Bitterroot Range and along their courses could be utilized as hay meadows and grazing grounds. Such use of these tracts should be rigorously prohibited. We have seen what an important part they perform in the conservation of the waterflow, and how essential is the preservation of their integrity, to the end that the present balance may not be disturbed. It is not to be denied that notwithstanding the considerable altitude at which the meadows are situated they are capable of producing crops of the more hardy forage grasses. To do this it is essential that they be ditched, so as to afford a rapid outlet for the spring drainage along their margins. The effect of ditching would be to throw into the valley the season's drainage much more rapidly than now, and thus diminish still further the available irrigation water during the growing season. Grazing on the meadows, while not so liable to work mischief, is still not to be commended, as it tends in all cases to break up the existing turf and facilitate the more rapid flow of water.

A. VIEW OF A SQUATTER'S CLAIM, WITHOUT ANY CULTIVATED GROUND, ON ABANDONED LOGGING CLAIM AT THE JUNCTION OF SOUTH AND LITTLE WEST FORKS OF BITTER-ROOT RIVER SHOWING ABOUT 90 PER CENT OF THE MERCHANTABLE TIMBER REMOVED FROM THE CLAIM.

B VIEW OF AGRICULTURAL LANDS OF THE SECOND CLASS IN THE SOUTH FORK VALLEY AT OVERWHICH SHOWING BRUSH LAND IN THE BACKGROUND AND CLEARED BRUSH LAND IN THE FOREGROUND.

The big canyons of the western Bitterroot Valley watershed are a constant menace to the agricultural interests of the main valley within their influence, though it is safe to say that the people in the valley do not realize it. The descent of these canyons is so rapid and the possible drainage into them so great that any considerable disturbance of the water-retaining factors at their heads or along their courses is liable to precipitate suddenly large volumes of water into their channels when the spring break-ups occur. With their rapid descent and narrow troughs a large quantity of water would readily gain sufficient force to sweep the great talus accumulations in their beds out upon the agricultural lands in the valley. For this reason no interference with existing conditions along these streams should be permitted, except such as have for their object an increase of forest growth or artificial retardation of the water flow through damming operations.

MINERAL LANDS.

The Bitterroot Range is deficient in mineral-bearing areas throughout the granite sections. Indications of such deposits have been discovered from St. Mary Peak southward to Big Creek, but none of the claims so far located have been opened up sufficiently to disclose their true character, with the exception of the Curlew claim, situated due west from the small village of Victor. None of the claims are inside the east boundary of the reserve. South of the granitic regions of the range there appears to exist a well-mineralized belt. The entire basins of the Little West Fork, Little South Fork, and South and West forks constitute the Overwhich mining district. The recorded claims in the district are mainly confined to the South Fork Basin. A single claim on the Little West Fork covering a mineral spring was the only one observed elsewhere in the district.

The claims in the South Fork Valley are scattered throughout its length. Many are located on Slate Creek, others between Slate and Overwhich, a number in the valley of the latter. The bottom of Hughes Creek is a compact mass of placer claims for nearly its entire length. The greatest number of lode claims exist above Mineral Point. Collectively there are probably several hundred such claims in the district. No lode claims have been opened up sufficiently to show permanent values. The placers along Hughes Creek are worked intermittently and are said barely to pay the expenses of working. On Coal Creek, a small stream emptying into the South Fork directly opposite Overwhich, deposits of coal occur. They are found in the north-central portions of the valley, are covered with a swampy lodgepole-pine forest, and comprise about 500 acres. The coal is of Tertiary age, but through great pressure has acquired a semi-bituminous texture. It is free from sulphur, so far as known, and burns freely. Two seams have been discovered, the upper one with a thickness of 12 feet, while the extent of the lower is unknown. Two claims, each of 160 acres, are maintained on this deposit. Coal lands very probably occur also on Bluejoint Creek, the next stream northward from Coal Creek that enters the South Fork.

FOREST ZONES.

Two forest zones are represented in the Bitterroot Valley—the yellow-pine and the subalpine-fir zones. Of the 787,200 acres, which it is estimated represent the area in the Bitterroot River Basin within the reserve, about 26 per cent, or nearly 205,100 acres, belong to the zone of the yellow pine, and 74 per cent, or about 582,100 acres, to the zone of the subalpine fir.

The acreages in these estimates may be found to need correction when accurate surveys have established the absolute area, but the percentages are substantially correct. In the estimate of the subalpine zone the areas high enough to come within a truly alpine classification are also included. The yellow-pine zone is distributed as follows:

	Square miles.
Main Bitterroot Valley from St. Mary Peak to a point west of and opposite to the junction of East and West forks, 7.5 per cent of 400 square miles	30.00
Upper portion of West Fork Basin, 20 per cent of 95 square miles	19.00
Little West Fork, 15 per cent of 155 square miles	23.25
Little South Fork, 44 per cent of 90 square miles	39.60
South Fork, 44 per cent of 470 square miles	206.80
East Fork, 9 per cent of 20 square miles	1.80
Total	320.45

The altitudinal limit in this region of the yellow-pine zone is about 5,800 feet above sea level. In the portion of the reserve north of the West Fork it occupies the slopes that face directly south or east and those that front on the valley up to the above elevation. In the canyons it extends from 2 to 3 miles above their outlet into the main Bitterroot Valley. In the basins of the West Fork and South Fork, with their lesser tributaries, it occupies the south and west facing slopes, and also those with a northern and eastern exposure to elevations of 4,800 to 5,000 feet. It extends in the bottoms of these valleys and side canyons in more or less continuous blocks to within 2 to 5 miles of their heads. In the smaller canyons it is often lacking on the northern slopes, with the exception of a narrow, irregular belt just above the valley trough. Outside the reserve in the valley below the main forks it occupies the entire west side of the valley from the forks nearly to the mouth of Roaring Lion Creek, opposite Grantsdale, with the exception of a strip a mile or less in width. Below the mouth of Roaring Lion Creek it recedes westward to near the base of the mountains, sending out irregular lobes at intervals until the Lolo Fork is reached, when it takes a long westward sweep, conforming to the curve of the range. The largest area in the main Bitterroot Valley covered with a nearly solid and pure growth of the yellow pine lies between Roaring

Lion Creek and Trappers Creek where it empties into the West Fork, and comprises about 145 square miles, or 95,800 acres.

On the east side of the valley it fringes the tributary canyons, sometimes forming considerable bodies of nearly pure growth. On the spurs fronting the valley on this side below Grantsdale the zone is confined to a narrow belt nearly at its upper limit. Above Grantsdale it descends, with sparsely timbered hillsides and scattered groves, to the level of the valley, or nearly so. Near Stevensville two eastward-and-westward extensions of the zone meet and stretch across the valley.

The subalpine and alpine areas constitute the greater portion of the reserve in the basin. North of the West Fork they cover all slopes having a northern or direct western exposure. They also occupy the summits of the ridges and the south and east facing slopes above 5,800 feet. In the main canyons the subalpine zone begins from 2 to 3 miles back from their outlets and continues to their heads. All slopes and summits of the main range belong either to the alpine or to the subalpine zone. The lower limit of its range is indefinite, depending on water supply and exposure. Thus in the canyons the subalpine zone may descend to 4,200 feet above sea level, or 1,800 feet below the highest level of the yellow-pine on southern slopes.

The zone is less extensively developed in the valleys of the West Fork and the South Fork and their tributaries. It is here found on the summits and northern slopes above 5,000 feet elevation. It likewise occupies the wet and swampy bottoms of the canyons in interrupted belts to within 2 to 4 miles of their outlets, alternating with blocks of the yellow pine where the ground is dry or well drained. Of the entire subalpine and alpine tracts within the reserve limits in the basin, about 43.4 per cent, or 370 square miles, occur in the region north of the West Fork Basin, where the total area is estimated to contain but 400 square miles. The remainder, or 483 square miles, is distributed among the basins of the West Fork and the South Fork and their tributaries.

The areas of the subalpine zone outside the reserve are comparatively small in the west half of the Bitterroot Basin. They consist of the slopes and canyons cut off from the main body of the range by the east boundary line. On the east side of the valley the mountain summits, stretching back to the main range of the Rocky Mountains, are covered by the zone.

The species of forest trees comprising the arborescent growth in the zones are as follows:

Species of trees comprising the arborescent growth.

I. YELLOW-PINE ZONE.

Yellow pine	Pinus ponderosa.
Lodgepole pine	P. murrayana.
Red fir	Pseudotsuga taxifolia.
White fir	Abies grandis.
Balsam (balm of Gilead)	Populus balsamifera.

II. SUBALPINE ZONE.

Lyall tamarack	Larix lyallii.
Subalpine fir	Abies lasiocarpa.
Lodgepole pine	Pinus murrayana.
White-bark pine	P. albicaulis.
White fir	Abies graudis.
Engelmann spruce	Picea engelmanni.
Yew	Taxus brevifolia.

The relative proportions in which these species occur are about as follows:

Relative proportions of species.

I. YELLOW-PINE ZONE.

	Per cent.
Yellow pine	30
Lodgepole pine	6
Red fir	60
White fir	2
Balsam (balm of Gilead) Aspen Semi-arborescent willows and other species	2
	100

II. SUBALPINE ZONE.

Subalpine fir	5
Lodgepole pine	90
White-bark pine Lyall tamarack White fir Engelmann spruce Yew and semi-arborescent willows	5
	100

These estimates are based on trees having basal diameters above 4 inches.

The species utilized for lumbering (logging) purposes are confined to those that grow in the yellow-pine zone, and practically to yellow pine. Other trees—yellow pine, lodgepole pine, red fir, white fir, balsam (balm), and aspen—are used only to a trifling extent. For other purposes, such as posts, fencing material, mining timbers to be used on the ground where the trees grow or immediately adjacent, the proportion is about as follows:

	Per cent.
Yellow pine	30
Lodgepole pine	50
Red fir	20
White fir	..
Balsam (balm)	..
Aspen	..
	100

None of the subalpine species are utilized except the lodgepole pine, which is used by the miners in their prospect tunnels and shafts for lagging, when the workings are situated so high that no other species is available.

A. YELLOW-PINE FOREST NEAR OVERWHICH, ON SLOPES FACING WEST.

B. LODGEPOLE-PINE FOREST AT THE HEAD OF COAL CREEK, IN THE SOUTH FORK BASIN.

RANGE IN SIZE AND AGE OF TREES.

YELLOW-PINE ZONE.

The variation in size of the yellow pine is more in the direction of the height of the clear trunk than the diameter. At its uppermost limit of 5,800 feet many individuals occur with diameters fully equal to those at lower levels. The clear trunk, however, is deficient in length, often not measuring more than 6 to 8 feet from the ground to first branches of distinctive crown. Within the reserve limits the most valuable growths of the species are found between elevations of 3,700 to 4,800 feet above sea level. The best-developed individuals occur in the bottoms of the largest valleys and on hill slopes with a fair depth of soil and moderate seepage. In the main Bitterroot Valley outside the reserve limits the tree attains its greatest stature and density on the terraces above Grantsdale, on the west side of the river, between elevations of 3,600 to 4,200 feet. On the dry hill slopes throughout the basin above altitudes of 4,800 feet it is usually much scattered and dwarfed in stature.

Nearly always, wherever found in the basin, the hemlock-spruce is undersized. It is near its eastern limit in this latitude, and the annual precipitation, together with the natural poverty and shallowness of the soil, greatly modify its growth. It is never found to equal, in any degree, the species as it occurs west of the Bitterroot Range. Its largest dimensions are reached on the more humid areas of the bench lands in the main valley and in the bottoms of the West Fork. It occurs most abundantly on those slopes in the yellow-pine zone that face northward in the West Fork, Little South Fork, and main South Fork valleys. On such slopes there is not one individual in a thousand that forms a distinct, clear trunk. The permanent crown usually begins within 2 or 3 feet of the ground and persists throughout the life of the tree. It is owing to its small size that the tree is not more extensively logged. It yields otherwise a class of material that is far more durable in underground mining operations than the yellow pine now employed.

The lodgepole pine, as it occurs in the yellow-pine zone, is of small growth and is found in circumscribed patches where the original growth of red fir has been burned off. The white fir is also commonly an undersized tree. Outside the reserve limits, however, in the main Bitterroot Valley, it sometimes attains a height of 100 feet or more, with diameters of 2 to 3 feet. The balsam, or balm of Gilead, and the aspen are both small and insignificant trees in the upper portion of the basin. Along the Little South Fork the aspen occasionally forms copses of nearly pure growth over areas of 10 to 20 acres. On the banks of Bitterroot River, below the forks, the balsam poplar becomes a good-sized tree, reaching a height of 60 to 70 feet, with diameters varying from 2 to 3 feet.

SUBALPINE ZONE.

The trees of the subalpine zone are generally deficient in development of clear trunks. The subalpine fir, white fir, and Engelmann spruce usually retain permanent living branches to within 4 or 5 feet of the ground at elevations of 6,000 feet and upward. The Lyall larch and white bark pine occasionally acquire a good trunk development with age, while the lodgepole pine rarely is more than a mere pole. The density of the subalpine forest varies with the species comprising it. On the high summits of the range north of the head of the Little West Fork the subalpine fir, Lyall larch, and white-bark pine form open, scattered growths separated by wide expanses of nearly bare areas. In the canyons Engelmann spruce, white fir, and lodgepole pine mingle with the subalpine fir and form forests of considerable density. Above the zone of the yellow pine and extending to about 6,500 feet elevation there is often found an excessively close growth of lodgepole pine. It is especially well developed at the head of all the canyons that enter the Bitterroot Basin south from the head of the Little West Fork and on the broad front of the spurs that face the main Bitterroot Valley. The growth is a replacement of an older forest of subalpine fir and white-bark pine burned off a hundred or more years ago. The charred remains of the previous forest are found abundantly throughout the lodgepole-pine growth and give certainty on this point. The lodgepole-pine areas are the most characteristic in the subalpine zone. The closeness of the growth is very striking. The trees frequently stand so close that it is difficult for a man even on foot to force his way between them. The individual trees are always of slender growth, but of no great height, and the majority of them are short lived.

AMOUNT OF STANDING TIMBER.

YELLOW PINE.

The estimates for standing living timber on the reserve are based upon measurements of 16 inches and upward, basal diameter, for yellow pine and 8 inches and upward for red fir. Much the greater portion of the red fir is contained between diameters of 8 and 16 inches at the butt. Yellow-pine trees that will make saw logs 10 feet in length are included, and all red fir above the specified diameter, whether with a clear trunk or otherwise. A great deal of the yellow pine is defective, owing to resin cracks and partially barked spots on the trunks. The defects are due to repeated fires. In many localities, more especially in the South Fork Basin, as many as 50 per cent of the trees are thus affected. The defective portions constitute from 6 to 10 feet of the total length of the clear log. The defective portions of the trees are excluded from the estimates when the fire sears are more than 2 feet in length.

A. YELLOW-PINE FOREST NEAR THE OUTLET OF OVERWHICH CREEK, ABOUT 700 ACRES IN THE TRACT, AVERAGING NEARLY 8,000 FEET B. M. PER ACRE.

B. YELLOW-PINE FOREST IN THE BITTERROOT VALLEY NEAR KAMAS CREEK; CAPACITY OF THE TRACT PICTURED, ABOUT 15,000 FEET B. M. PER ACRE.

The acreage is computed on the basis of the relative percentage each area bears to the whole of each basin. Final surveys may change the acreage somewhat, especially in the portions of the reserve north of the two main Bitterroot forks and in the Little West Fork Valley.

Acreage and amount of yellow-pine timber.

Valley.	Acres.	Feet B. M.
Main Bitterroot	6,500	6,500,000
West Fork	4,850	19,128,000
Little West Fork	6,000	30,400,000
Little South Fork	8,900	26,700,000
South Fork, exclusive of tributaries above Bluejoint Creek	22,000	88,500,000
Bluejoint Creek	1,800	3,000,000
Slate Creek	1,340	5,860,000
Coal Creek	3,200	19,600,000
Overwhich Creek	5,620	18,440,000
Hughes Creek	11,200	33,080,000
Chicken and Wood creeks	350	350,000
Total	71,760	251,558,000

RED FIR.

Acreage and amount of red-fir timber.

Valley.	Acres.	Feet B. M.
Main Bitterroot	12,000	6,000,000
West Fork	8,000	9,600,000
Little West Fork	5,500	6,500,000
Little South Fork	3,500	7,000,000
South Fork, exclusive of tributaries above Bluejoint Creek	65,000	130,000,000
Bluejoint Creek	1,200	1,200,000
Slate Creek	2,000	1,000,000
Coal Creek	3,000	4,500,000
Overwhich Creek	16,700	58,430,000
Hughes Creek	25,000	65,000,000
Chicken and Wood creeks	2,000	2,400,000
Total	143,900	291,630,000

The areas included in the foregoing estimates are those that have not been logged systematically. To them should be added the remnants of the forest yet standing upon various culled tracts, as follows:

Timber standing on culled tracts.

Basin.	Acres.	Feet B. M.
West Fork	2, 400	3, 600, 000
Little West Fork	5, 000	6, 000, 000
South Fork	1, 200	1, 500, 000
Little South Fork	160	160, 000
Total	8, 760	11, 260, 000

Of this amount about two-thirds, or 7,506,000 feet, is red fir; the rest is pine, composed principally of crooked and deformed trees not considered fit for logging purposes when the balance was removed. Occasional trees of the Engelmann spruce are found mixed with the red fir, especially in the low, wet valleys. The tree occurs in such insignificant amounts that it has not been deemed necessary to separate it. What there is of it is included in the estimates of hemlock-spruce.

Recapitulation of estimates of standing timber in the yellow-pine zone.

Kind of timber.	Acres.	Feet B. M.
Yellow pine on	80, 520	255, 312, 000
Hemlock-spruce on	152, 660	299, 136, 000
	....	554, 448, 000

In the above estimates the areas with yellow pine and red fir overlap. Separated, the acreage is estimated to stand as follows:

	Acres.
Yellow pine, pure growth	30, 140
Yellow pine and hemlock spruce	92, 300
Hemlock-spruce, pure growth	67, 000
Total	189, 440

The last number represents the area now producing merchantable timber in the yellow pine zone.

The tracts in the western portion of the Bitterroot Valley, outside the reserve, which produce merchantable timber, are chiefly within the section from Roaring Lion to Trapper Creek. This area carries an exceptionally heavy body of timber, in general of better quality than elsewhere in the western section of the basin. The acreage of the

YELLOW-PINE FOREST IN THE BITTERROOT VALLEY BETWEEN KAMAS AND LOST HORSE CANYONS; CAPACITY OF THE TRACT PICTURED, ABOUT 30,000 FEET B. M. PER ACRE.

tract is about 95,800 acres, of which about 65,000 acres are bench lands and 30,800 mountain slopes. The bench lands average about 6,000 feet per acre and the hill slopes about 2,500 feet of all kinds of timber above 16 inches diameter at the base. Occasional tracts on the terraces will scale as high as 30,000 feet per acre, but they are exceptions, and the foregoing estimates are believed to be substantially correct. The totals would be as follows:

	Feet.
65,000 acres, average 6,000 feet	390,000,000
30,800 acres, average 2,500 feet	77,000,000
Total	467,000,000

The bulk of this is yellow pine; less than 2 per cent, or 9,340,000 feet B. M., is red fir.

Most of the land in this tract has been surveyed and passed into the hands of private owners long since, but there is yet a strip of 25,000 acres or more, lying along and on the lower slopes of the mountains, with some bench land near Trapper Creek, neither surveyed nor sold, and the east line of the reserve should be shifted far enough eastward to cover it. Below Roaring Lion Creek the valley and the accessible slopes abutting on it have long been culled of the merchantable timber, except some small tracts held by private owners, in the aggregate an inconsiderable amount.

The timber in the subalpine zone is not of merchantable quality, and is not accessible. Its chief value lies in its capacity, while in the growing state, as a regulator of the water flow at the sources of the streams.

TIMBER CUTTING.

The character of the timber cutting up to date falls under three heads:

1. Cutting by squatters to improve their holdings.
2. Cutting by pretended squatters who held the land temporarily while logging it, and afterwards abandoned their claims.
3. Cutting under timber permits granted by the Secretary of the Interior.

The cuttings under the first class form the smallest and those under the third class the largest part of the total, while those under the second are intermediate. The migratory squatters that constituted the second class depended for the sale of the logs chiefly on the loggers operating under permits, though usually, as a matter of common report, the holders of the timber-cutting permits simply paid the squatters a lump sum for the privilege of cutting over their holdings. The logging under the permits was carried on by the Bitterroot Development Company, and the crops of logs were converted into lumber at their sawmill in Hamilton, in the Bitterroot Valley. Their operations have extended throughout the timber in the more accessible portions of the Bitterroot

Valley, with the exception of the South Fork Basin above Rambo Flat. Within the reserve they have cut over the following areas:

	Acres.
Valley of the West Fork	1,800
Valley of the Little West Fork	2,600
Valley of the Little South Fork	200
Valley of the main South Fork	1,900
	6,500

The cutting upon these tracts varies from total, or nearly so, in the valley trough and on adjacent bench lands, to 20 per cent on tracts farther removed. In addition to the acreage included in the estimate, small tracts of a few acres each have been culled from 10 to 50 per cent. They are scattered along the forest in various places, and probably foot up 1,200 or 1,500 acres. It is impossible to ascertain the exact quantity cut from these lands, as nothing is left to show the average height of the trees that were felled. Estimating by the adjacent unlogged forest, and allowing for a somewhat greater height of the timber in the valley trough than on the hillsides, it may be assumed that the cut amounted to about 50,000,000 feet B. M., in round numbers. The cutting was accompanied by a great deal of unnecessary waste. Only the choice portions of the logs were taken. Trees were felled carelessly, breaking and splintering adjacent ones. Trees were felled, sawed up into proper logging lengths, and left to rot. Logs were hauled together in piles for banking and abandoned. In no case were the tops disposed of, and they litter the ground in all directions with a vast mass of inflammable material.

Outside the reserve, logging operations have been carried on everywhere throughout the valley. Below Grantsdale fully 90 per cent of the accessible merchantable timber has been cut. Above that point there has been considerable cutting at the mouth of Lost Horse Creek, amounting to 75 or 80 per cent over areas aggregating, perhaps, 5,000 acres. Most of the valley of Tincup Creek has been logged clean of yellow pine, and the valley of the West Fork, from its junction with the East Fork to the reserve line, is logged off clean in the trough, and from 20 to 95 per cent on the slopes. In the heavy body of timber between Lost Horse and the West Fork, cutting has been done on many small tracts along the edges and in the interior, some by settlers taking up agricultural claims and some by migratory squatters. Most of the lands here are now owned by parties that have purchased under the Timber and Stone Act and are husbanding the standing timber against the day of scarcity. The disposal of these lands under the Timber and Stone Act furnishes good arguments for the repeal of that act. The lands were originally purchased by individuals who, upon acquiring ownership, immediately transferred their holdings to lumber corporations. It is a matter of common report that the purchase money was supplied by these same corporations, and a bonus besides to cover the value of the individual's purchasing right under the law. Although sold under the Timber and Stone Act, it is a patent fact that there are many tracts which are as good agricultural lands, when the timber is removed, as any in this section of the Bitterroot Valley. The legal price ($2.50 per acre) at which the lands were sold was ridiculously low. There are large tracts averaging from 10,000 to 20,000 feet of merchantable timber per acre, or as much as 3,200,000 feet to a quarter section. Even at a stumpage of no more than 50 cents per thousand, a tract of the latter class would have a value of $1,600. But, in fact, timber so easily accessible is worth now about $3 per thousand, or $9,600 for the amount on a quarter section of this character, and when the land is fit for agricultural purposes, upon removal of the timber, about $800 more. Yet such lands have been sold for the sum of $2.50 per acre.

The merchantable timber in the Bitterroot Valley will not last many years at the present rate of consumption. The yellow pine within the reserve could, with ease, be logged off in five years. At a similar pace it is safe to say that less than twenty years would see all the accessible merchantable pine in the valley converted into logs or lumber.

The merchantable timber in the reserve is comparatively easy of access, and can all readily be logged. The canyons from the West Fork northward usually have a spring freshet high enough to float logs into the main river, and are mostly clear enough from bowlders to permit driving as far up as the yellow pine extends. The West Fork, Little West Fork, Little South Fork, and the main South Fork all have deep enough water in the spring to drive on.

FOREST FIRES.

The fires in the Bitterroot Basin have been as extensive as elsewhere in the West, but have done far less damage to the merchantable timber. This is due to the resistance offered by the yellow pine and to the small quantity of litter and humus in the forest. The ground in this kind of growth is always covered with a thin layer of pine needles—never a proper humus—and is usually free from undergrowth, or has but a minimum. Grasses or sedges in bunches cover the ground thinly, hardly ever forming a continuous sod. In consequence fire runs through the forest rapidly. While, therefore, the yellow pine has a better chance to escape destruction than most of the other western conifers, yet it yields to repeated fires and is eventually consumed. Its vulnerable point is just at the base, where there is always an accumulation of flakes of bark thrown off, which contain more or less resin. As the fire runs through the thin grass growth it finds more than a temporary lodging place in the accumulated bark débris, and a hotter fire is the result. A point of entrance to the interior of the tree is afforded by resin lumps on the trunk, which mark the former point of attachment of cast-off branches. The fire catches in the resin lump, burns into the tree, and is finally extinguished in the sappy wood of the interior, but not before it has created a fresh wound, which is soon covered with an exudation of resin and furnishes a larger burning surface for the next fire. The resinous-wood patch grows larger with each recurring fire, until the tree finally yields and is entirely consumed, or so weakened that the first heavy wind breaks it off.

The fire sears on the yellow pine are extremely common in the Bitterroot Basin. In the valley of the West Fork and Little West Fork more than 30 per cent of the pine has sears extending from 2 to 8 feet from the ground and varying in depth from a mere bark burn to 6 or 8 inches. At the mouth of Hughes Creek in the main South Fork Basin there is scarcely a tree over a tract of 1,200 acres that has not a big sear, rendering from 5 to 10 per cent of the tree worthless. The greatest damage from fire among the merchantable-timber species occurs in the pure red-fir areas. Growing mostly on northern slopes or in moist valleys, an appreciable quantity of humus has collected, and fire is in consequence more destructive.

Comparatively little of the pure yellow-pine or the mixed yellow-pine and red-fir growths has been destroyed, probably not more than 5 per cent, or about 10,000 acres of the entire zone. The destruction has been greatest in the pure, or nearly pure, red-fir forest, where we estimate that upon more than 50,000 acres the forest has been destroyed from 60 per cent to total. The burnt areas are found principally on the slopes facing north in the valleys of the West Fork, Little West Fork, and Little South Fork. The destruction in the latter has been much the greatest. Almost the entire slope of the valley south of the stream from its junction to its head has been burned over within the last thirty-five or forty years, and considerable tracts have been subjected to two consecutive fires within that period, completely denuding them. The slopes in the South Fork Valley facing the east and the region about its head above Mineral Point have been much devastated in later years. During the present summer the fires destroyed a large amount of red fir in the middle sections of Hughes Creek, burning over some 1,500 to 2,000 acres. It is in the subalpine zone, however, that the fires have been the most widespread. Fully 80 per cent of the wooded portions of the zone have been visited by fires within the last twenty-five or thirty years. By far the most extensive burns date back only ten or fifteen years. From Big Hole Pass to the ultimate head of the Little West Fork nearly every forested area at the head of the streams has been more or less burned. At the head of the Little West Fork, the Little South Fork, and the tributaries coming from the west into the main South Fork the lodgepole-pine forest is almost totally destroyed. The same conditions prevail along the divide and the upper slopes between the East Fork and the South Fork. More than 50 per cent of the lodgepole pine on the spurs facing the Bitterroot Valley below the main forks has shared the same fate. The destruction in the lodgepole-pine areas has been far more com-

FIRE SCAR ON A YELLOW-PINE TREE NEAR THE MOUTH OF OVERWHICH CREEK, ILLUSTRATING HOW FOREST FIRES DESTROY THIS SPECIES.

plete than elsewhere, owing to its greater density and more abundant litter. The causes of the fires are the same here as elsewhere. Hunters and trappers, prospectors and travelers, in the past have not exercised the least care in the matter of their camp fires. The largest burns are adjacent to the valleys of the Little South Fork and the main South Fork. Through the former runs a highway connecting the Bitterroot basins with those of the Clearwater—the Nez Perces trail—and along the latter are clustered most of the known mineral deposits in the region.

In comparison with the amount of standing timber, merchantable and otherwise, the fire damage during the last forty years may be thus summarized, roughly:

	Per cent.
Pure yellow-pine growth	1
Mixed yellow-pine and red-fir growth	4
Pure red-fir growth	50
Lodgepole-pine growth	80

Expressed in feet the loss would probably stand approximately as follows:

	Feet B. M.
Pure yellow-pine growth	2, 553, 120
Mixed yellow-pine and red-fir growth	5, 411, 840
Pure red-fir growth	130, 000, 000
Total	137, 964, 960

From the *present* commercial standpoint with reference to lumber values in the Bitterroot Basin no damage has resulted from burning the lodgepole pine and but little from the destruction of the red fir.

It is clearly evident that within the last four or five years the fires have decreased in frequency and extent. There is a general and laudable public sentiment in the valley adverse to fire setting, in great contrast to the indifference prevailing elsewhere in the West. Through the efforts of the Anaconda Copper Mining Company posters, with extracts from the Montana State laws relative to fire setting and the penalties attached, have been pretty generally distributed through the valley and are found tacked up at all the usual camping places and along the traveled trails. But aside from this, the people are of themselves beginning to realize that the growing timber is a factor in the wealth of the community easy of exhaustion and slow of restoration, and the drift of sentiment is therefore decidedly hostile to forest fires and their originators.

The damage consequent upon fires in the yellow-pine stands has consisted not only of the fire sears already described but, of greater moment, the check on the reproduction of the species. The absence or comparative scarcity of young trees from 5 to 20 years old is very striking, even where the forest is, to all appearances, the best preserved. On the pure red-fir areas the burnt tracts are rapidly being reforested, with the original species as the preponderating growth. The lodgepole pine and, in general, all the burnt subalpine tracts, are reforesting but slowly, and when the lodgepole pine has been burned twice in succession, not at all. In the reforesting process it usually comes again as the first growth, and shows everywhere a tendency to encroach on the territory occupied by the other species of the zone.

The people living in the upper portion of the valley have become aware of the fact that since the lodgepole-pine regions were so extensively burned the spring freshets are greater and the stream channels in the canyons are constantly widening. This is perfectly in accordance with conditions that are manifesting themselves in other sections similarly situated with reference to drainage and forest destruction. The sentiment consequently is strongly in favor of the rigid exclusion of forest fires from the lodgepole-pine region in the future, notwithstanding the valueless character of the tree with reference to the lumber supply it affords.

TABLES.

BITTERROOT RESERVE IN MONTANA.

AGRICULTURAL LANDS.

The agricultural lands are situated in the valleys of the South Fork, Little South Fork, Little West Fork, and West Fork, and consist of—

1. Lands on which the timber has long been cut and removed and which are now under the plow.

2. Areas along streams with a more or less dense covering of brush, willows, or coarse sedges, with occasional small tracts brought under the plow. Their aggregate acreage and distribution are as follows:

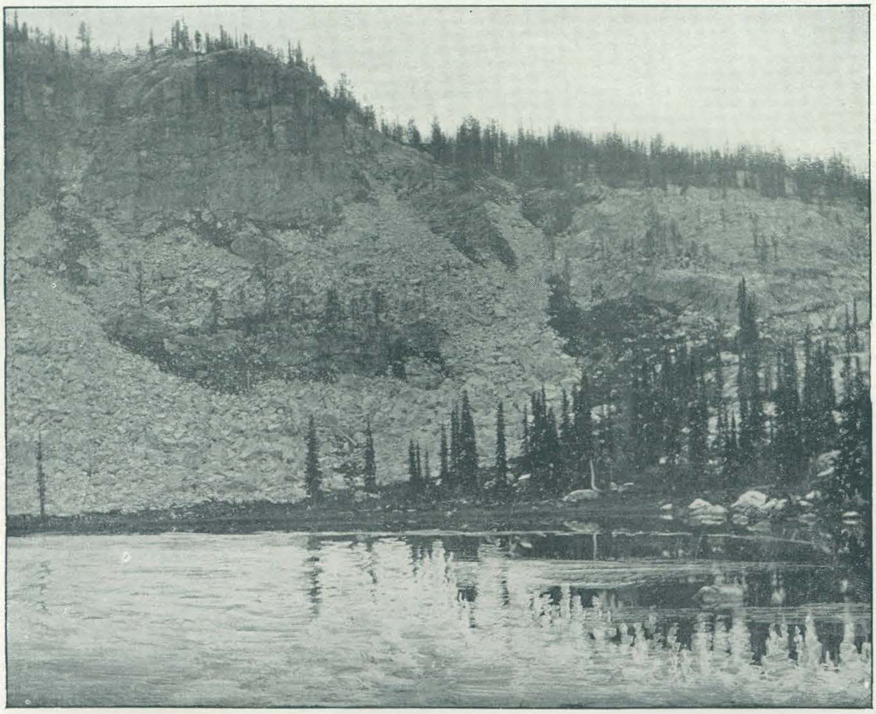
Agricultural lands in class 1.

	Acres.
Little West Fork	45
West Fork	10
Total	55

Agricultural lands in class 2.

	Acres.
In upper half of Little South Fork Valley	200
In South Fork Valley below and including Rambo Flat	150
In South Fork Valley from Slate Creek to Overwhich	250
In South Fork Valley between Overwhich and Hughes Creek	150
In Overwhich Creek	120
In Hughes Creek	350
In Wood and Chicken creeks	100
In South Fork Valley at Mineral Point	120
Total	1,440

A. BURNT RED-FIR AREAS IN THE WEST FORK VALLEY.



B. ALPINE LAKELET NEAR THE HEAD OF ONE OF THE BEAR CREEK TRIBUTARIES; MAIN RANGE OF THE BITTERROOT MOUNTAINS IN THE BACKGROUND.

Agricultural lands under cultivation in class 2.[1]

	Acres.
In South Fork Valley below Overhwhich	5
In South Fork Valley at Overwhich	20
In South Fork Valley above Overwhich	2
Total	27

Total agricultural lands.

	Acres.
Little West Fork and main West Fork basins	55
Little South Fork and main South Fork basins	1,440
Total	1,495

Total agricultural lands under cultivation.

	Acres.
Little West Fork and main West Fork basins	55
Main South Fork and Little South Fork basins	27
Total	82

ACREAGE OF FOREST ZONES.

Approximate acreage of the forest zones.

I. ZONE OF THE YELLOW PINE.

	Acres.
Bitterroot Valley to Trapper Creek	19,200
Upper portion of West Fork Basin	12,160
Little West Fork Basin	14,880
Little South Fork Basin	25,344
South Fork Basin	132,352
East Fork Basin	1,152
Total	205,088

II. ZONE OF THE SUBALPINE FIR.

	Acres.
Bitterroot Valley to Trapper Creek	236,800
Upper portion of West Fork Basin	48,640
Little West Fork Basin	84,320
Little South Fork Basin	32,256
South Fork Basin	168,448
East Fork Basin	11,648
Total	582,112

SPECIES OF TREES.

Species of trees composing the forest zones.

I. ZONE OF THE YELLOW PINE.

Yellow pine	Pinus ponderosa.
Lodgepole pine	P. murrayana.
Red-fir	Pseudotsuga mucronata.
White fir	Abies grandis.
Balm	Populus balsamifera.
Aspen	P. tremuloides.
Birch	Betula occidentalis.

[1] In several small patches.

II. ZONE OF THE SUBALPINE FIR.

Lyall tamarack	Larix lyallii.
Subalpine fir	Abies lasiocarpa.
Lodgepole pine	Pinus murrayana.
White-bark pine	P. albicaulis.
Engelmann spruce	Picea engelmanni.
Yew	Taxus brevifolia.

Proportion of species composing the zones.

I. YELLOW-PINE ZONE.

	Approx. per cent.
Yellow pine	30
Lodgepole pine	6
Red fir	60
White fir	2
Balm; Aspen; Other species, semi-arborescent willows and alders	Trifling.
	100

II. SUBALPINE-FIR ZONE.

	Approx. per cent.
Subalpine fir	5
Lodgepole pine	90
White-bark pine	2
White fir; Lyall tamarack; Engelmann spruce; Yew and semi-arborescent willows	Trifling.
	100

Estimates based on basal diameters of 4 inches.

Range in size and age of trees.

I. YELLOW-PINE ZONE.

Species.	Height.	Diameter.	Clear trunks.	Age.
	Feet.	*Inches.*	*Feet.*	*Years.*
Yellow pine	70 to 150	15 to 40	15 to 75	80 to 275
Lodgepole pine	40 to 90	8 to 14	10 to 45	50 to 100
Red fir	25 to 100	8 to 20	5 to 35	50 to 150
White fir	20 to 150	6 to 36	0 to 20	40 to 200

II. SUBALPINE ZONE.

Lyall tamarack	30 to 75	6 to 48	0 to 30	70 to 400
Subalpine fir	50 to 90	6 to 18	0 to 15	40 to 90
Lodgepole pine	50 to 90	3 to 14	0 to 20	20 to 100
White-bark pine	30 to 50	6 to 30	0 to 20	60 to 300
White fir	30 to 60	4 to 12	0 to 15	20 to 70
Englemann spruce	40 to 100	6 to 20	0 to 30	30 to 200

AMOUNT OF TIMBER.

Estimated amount of merchantable standing timber.

I. YELLOW PINE.

Drainage area.	Acres.	Amount.
		Feet B. M.
Main Bitterroot Valley	6,500	6,500,000
West Fork Valley	4,850	19,128,000
Little West Fork Valley	6,000	30,400,000
Little South Fork Valley	8,900	26,700,000
South Fork Valley, exclusive of tributaries above Bluejoint Creek	22,000	88,500,000
Bluejoint Basin	1,800	3,000,000
Slate Creek Basin	1,340	5,860,000
Coal Creek Basin	3,200	19,600,000
Overwhich Basin	5,620	18,440,000
Hughes Basin	11,200	33,080,000
Chicken and Wood basins	350	350,000
Total	71,760	251,558,000

This gives an average of about 3,505.5 feet B. M. per acre.

These estimates are made up from the aggregates of many small parcels in the various basins, running all the way from 1,000 to 8,000 feet per acre, and are on a basis of 16 inches diameter at the base.

The red fir, as it grows in the Bitterroot Basin, can not strictly be considered as merchantable timber, owing to deficient development of trunk. More than 80 per cent included in the estimates are below 14 inches basal diameter.

II. RED FIR.

Drainage area.	Acres.	Amount.
		Feet B. M.
Main Bitterroot Valley	12,000	6,000,000
West Fork Valley	8,000	9,600,000
Little West Fork Valley	5,500	6,500,000
Little South Fork Valley	3,500	7,000,000
South Fork Valley, exclusive of tributaries above Bluejoint	65,000	130,000,000
Bluejoint	1,200	1,200,000
Slate Creek	2,000	1,000,000
Coal Creek	3,000	4,500,000
Overwhich	16,700	58,430,000
Hughes Creek	25,000	65,000,000
Chicken and Wood creeks	2,000	2,400,000
Total	143,900	291,630,000

In these estimates are included trees with diameters down to 8 inches at the butt. Trees with clear trunks are uncommon except in the lowest valleys.

Estimate of acreage of culled and logged areas, with the amount of standing timber.

Valley.	Acres.	Amount.
		Feet B M.
West Fork	2,400	3,600,000
South Fork	1,200	1,500,000
Little West Fork	5,000	6,000,000
Little South Fork	160	160,000
Total	8,760	11,260,000

Red fir constitutes about 66 per cent, or 7,506,000 feet, mostly under 14 inches basal diameter; the balance is pine, largely made up of crooked or otherwise defective trees.

Summary of estimates of standing merchantable timber in the yellow-pine zone.

	Acres.	Amount.
		Feet B. M.
Yellow pine on	80,529	255,312,000
Red fir on	152,660	299,136,000
		554,448,000

In this estimate the yellow-pine and red fir areas overlap. Separated, the acreage is estimated to stand as follows:

	Acres.
Yellow pine, nearly pure growth	30,140
Yellow pine and red fir	92,300
Red fir, nearly pure growth	67,000
Total	189,440

This represents the area now producing merchantable timber in the yellow-pine zone of the Bitterroot Forest Reserve in Montana.

WASHINGTON FOREST RESERVE.

By H. B. Ayres.

LIMITS.

This is the largest of the reserves created by Executive order of February 22, 1897. It lies in the northern part of the State of Washington, and includes the summit and both slopes of the Cascade Range. Its limits, as set forth in the Executive order, are as follows:

Beginning at the point for the southwest corner of township twenty-nine (29) north, range eight (8) east, Willamette meridian, Washington; thence northerly along the unsurveyed range line between ranges seven (7) and eight (8) east to the point for the northwest corner of township thirty-two (32) north, range eight (8) east; thence easterly along the unsurveyed eighth (8th) standard parallel north to the point for the southwest corner of township thirty-three (33) north, range twelve (12) east; thence northerly along the unsurveyed range line between ranges eleven (11) and twelve (12) east to the point for the northwest corner of township thirty-six (36) north, range twelve (12) east; thence westerly along the unsurveyed ninth (9th) standard parallel north to the point for the southwest corner of township thirty-seven (37) north, range seven (7) east; thence northerly along the unsurveyed range line between ranges six (6) and seven (7) east to its point of intersection with the international boundary line between the State of Washington and the British Possessions; thence easterly along said international boundary line to the point for the unsurveyed range line between ranges twenty-two (22) and twenty-three (23) east; thence southerly along said unsurveyed range line, subject to the proper easterly or westerly offsets on the ninth (9th) and eighth (8th) standard parallels north, to the point for the southeast corner of township twenty-nine (29) north, range twenty-two (22) east; thence westerly along the unsurveyed and surveyed seventh (7th) standard parallel north to the point for the southwest corner of township twenty-nine (29) north, range eight (8) east, the place of beginning.

These limits inclose an area estimated at 3,594,240 acres, or about 5,600 square miles. The area assigned to me for examination comprised somewhat more than one-half the reserve, or, in round numbers, 3,000 square miles.

TOPOGRAPHY.

This region is composed of the western spurs and slopes of the Cascade Range from the divide nearly down to the level country bordering Puget Sound. The divide of Cascade Range crosses the national boundary in latitude 120° 45′, and pursues a course across the forest reserve somewhat west of south, crossing the south boundary in about latitude

121°. Its course is extremely winding, swinging to the west to exclude the headwaters of Lake Chelan, and again to the east to include those of Sauk River. The altitude of the central portion of the range varies from 5,500 feet in the lowest passes to more than 10,000 feet upon the highest peaks, the average probably being between 8,000 and 9,000 feet. This portion of the range is extremely rugged, containing many sharp, ragged peaks and great areas so rough as to be without soil, and consequently without vegetation, although only a trifling portion of the range is sufficiently high to be above the limits of timber.

The valleys are for the most part glacier carved, and are narrow, but gradually widen toward their lower ends. The lowest point within the reserve is in the valley of Skagit River, a few miles above Marblemount, and is about 300 feet above sea level.

The region is drained mainly by Skagit River, which, with its branches, drains the higher portions of the range throughout the whole breadth of the reserve. The main river heads in British Columbia and flows southward into the reserve, where it turns to the west at the mouth of Cascade River. It has numerous branches from the east, heading in the divide of the Cascade Range, among them Lightning Creek, Canyon Creek, Cascade River, and Sauk River, with its branches, the Suiattle and the Whitechuck. Heading farther to the west, and draining small portions of the reserve, are branches of the Nooksak in the north, and Stilaguamish River in the south.

The Cascade Range in this part of Washington is composed of granite and allied rocks. It is an old range and has suffered greatly from erosion, mainly from the action of glaciers, which in recent times have occupied all the gorges leading out of the range.

In the northwestern part of the reserve is a group of volcanic peaks, the central point of which is Mount Baker, with an altitude of 11,000 feet. From these peaks lava has been poured out over much of the surrounding country.

AGRICULTURAL LAND.

The only considerable areas of lands that can be made arable are on the benches in the valleys. The width attained by these partly arable benches along both forks of the Stilaguamish is 3 miles; along Sauk River, below the South Fork of the North Fork, 3 miles; along the Suiattle, extending 12 miles above the reserve boundary, 1 mile; along Cascade River, extending 6 miles above the reserve boundary, one-half mile; along Skagit River, from the international boundary to the mouth of Beaver Creek, 2 miles, and from Goodells to the reserve boundary, 2 miles; along Baker River, from Baker Lake to the reserve line, 4 miles; above Baker Lake, 1 mile; and along the North Fork of Nooksak River, below Ruth Creek, 1 mile. The total area is approximately 230 square miles.

MONTE CRISTO; PANORAMA FROM WILLMANN PASS, SOUTH HALF.

MONTE CRISTO; PANORAMA FROM WILLMANN PASS, NORTH HALF.

OCCUPANCY.

Aside from the cabins of mining prospectors, occupied during a small portion of the summer and autumn, there are scattered through the lower valleys small clearings, with stumps left, and houses usually made of split cedar boards, on lands taken as squatters' claims. Whether the object in taking these claims was timber or agriculture has not been determined. In nearly all cases where clearings have been made the land cleared has been seeded to grass. Some vegetables have been grown and, in a few cases, grain; but the remoteness from market and the difficulty of transporting produce over the trails renders farming for the general market unprofitable. Very few of the houses or cabins were found actually occupied during the progress of the examination.

In the Sultan Valley but one cabin was found, and that was the prospecting camp at the head of the stream. On Williamson Creek were 3 mining cabins vacant. On Pilchuck 12 clearings were found. Only 2 of these were occupied, one by D. P. Kelly, the other by a Mr. Gray. On the South Fork of Stilaguamish are nearly 30 residents, occupying the wide bottom land. The village of Silverton, with some 25 families, is also in this valley, and above Silverton are about 10 claims, most of them near Perry Creek. On the North Fork of the Stilaguamish are about 18 claims, on well-timbered land, most of which would make thoroughly good farms if cleared. On the South Fork of Sauk River the mining village of Monte Cristo has a population of about 1,000, but there is no agricultural land above Barlow Pass. On the North Fork of Sauk 12 cabins were found, 5 of which were habitable; only 1, however, was actually occupied. On the east bank of the main Sauk River, within the reserve and below the North Fork, are 11 houses, all of which are habitable. On Whitechuck there are 3 habitable cabins.

Below Whitechuck, on the west bank of the Sauk and above Darrington, are 12 clearings with cabins. Three of these seem to be inhabited. Below Darrington, within the reserve, are 3 cabins on the west bank and 5 on the east, nearly all of which are in good condition, accompanied by clearings mostly seeded to grass, the largest of which has an area of about 40 acres. On Cascade River, outside of the old mining camp of El Dorado, some 7 cabins were seen within the reserve. Most of these were habitable. The clearings were small.

On Skagit River, below the canyon and within the reserve, are 4 claims actually agricultural. Above the canyon are two of the most improved claims found within the reserve, McMillan's, on Beaver Creek, about 2 miles above its mouth, and Rolan's, on the east side of the Skagit, opposite the mouth of the Beaver. On Baker River, within the reserve, are 8 houses. Five of these, with small clearings, are occupied, and these are like farms. On Baker Lake is the State fish hatchery. On the North Fork of Nooksak there are 6 resident squatters within the reserve, who have each from 10 to 20 acres cleared and are growing vegetables and hay.

ROADS AND TRAILS.

Some 30 miles of the Everett and Monte Cristo Railway were within the reserve until washed out by the flood of 1897. Wagon roads were found between Barlow Pass and Goat Lake, from the mouth of Whitechuck River down Sauk River to the reserve line, and along Cascade River to 6 miles above the reserve line, altogether about 30 miles of wagon road.

Horse trails were found along the Pilchuck and Sultan rivers, Williamson Creek, Silver Creek, the North Fork of Stilaguamish, Martin Creek, Perry Creek, the North Fork of Sauk River, Cascade River, Slate, Canyon, and Ruby creeks, Skagit River, Baker River, and the North Fork of Nooksak River, altogether amounting to about 240 miles.

DRAINAGE.

The abundance of water in this region may be appreciated by the statement that not a spot was found within the reserve where the sound of falling water was not forced on the ear. Waters navigable, however, even for canoes are short and detached. Continuous steamboat navigation upon the Skagit River reaches within a mile of Marblemount, or within 8 miles of the reserve. Water power is remarkably abundant.

SOIL.

The soils of this varied region form a scale as endless as the alpine topography and climate could make from the rocks in these mountains. Granites, gneisses, porphyries, gabbros, lavas, quartzites, schists, shales, slates, and conglomerates have, where the streams cut across their bedding, contributed jointly toward the collection of soil and subsoil in the valleys below. In the valleys, therefore, we find the contributions of the various rocks mingled, the only classification being a physical one, dependent on the mechanical power of the water to carry the different materials. Toward the head of the valleys we find bowlders and gravels. Lower, where the torrents cease, there are sands, and in the plains below the alluvial sediments settled from the muddy floods.

This general action has been varied from time to time by obstructions to the drainage, which have backed up waters high in the mountains, and in these waters clays have settled. Further collections of fertile soil have been caused by beavers, whose dams have stopped sediments and moisture, forming occasional fertile areas where hay and vegetables would grow luxuriantly. The injurious action of rock and earth slides and of torrential wash is of frequent occurrence, sterilizing for a time the surface covered by them.

VIEW OF CHURCH MOUNTAINS, LOOKING NORTH FROM NEAR TWENTYMILE POST, RUTH CREEK VALLEY, WASHINGTON; VALLEY OF NORTH FORK OF NOOKSACK RIVER, SHOWING BURNT AREA ON THE RIGHT.

VIEW SOUTHWEST FROM HANNIGAN PASS, WASHINGTON; HEAD OF NORTH FORK OF NOOKSACK RIVER.

The smaller valleys or basins, however, which lie parallel with the trend of the various rock formations, retain the original characteristics of soils from such rocks, and a general idea of the soil may be briefly given by the statement that the main divides are usually granitic and against them lie the Huronian or Taconic schists. Aside from the fertility of the soil, vegetation also depends largely on the physical character of these rocks. The granitic mountains are rounded and yield micaceous porous earth; the Taconic, which are sharply serrated and difficult of access, yield cold hard clays. Vegetation was found shrubby and grassy on the granitic lands, and more heavily wooded on the schists and slates.

SUBSOIL.

A tough blue clay subsoil is common in most of the lower valleys, especially at elevations between 500 and 1,500 feet. The wide and fertile valley of Baker River is one of the most conspicuous examples of such a formation; but on the Pilchuck, the Stilaguamish, the North Fork of the Sauk, the Whitechuck, the Cascade, the Upper Skagit and its tributaries, and the Nooksak these clay banks frequently appear and characterize the land where they lie near the surface. In addition to this deposit of blue clay, which seems to have been quite general, minor deposits of varying clayey material are frequent, settled above temporary dams formed either by slides of earth from a mountain side or by torrential wash from a tributary. Such dams have formed catch-basins in which sediments have settled.

HUMUS.

On the lower unburnt areas 1 foot is a common depth of the well-rotted litter or humus. This diminishes in proportion to the thoroughness of the drainage, very little being found on the highest and driest hills. In the high altitudes where not wooded but little humus is found, the treeless areas being especially liable to wash from melting snows.

The humus on burnt areas varies with the intensity of the fire. The large burnt areas on Ruby, Slate, and Canyon creeks have very little humus left.

FOREST LITTER.

In general the quantity of forest litter varies with the vigor of the vegetation producing it. Unburned for centuries, some of the lower lands where moisture and temperature are fairly uniform have accumulated fallen leaves, branches, and trunks in great quantity.

They often form such a barrier that progress through them, even on foot, is very slow and difficult, and is only possible by frequent climbing and detours. The difficulty is greatly increased by the uncertainty of the footing. The cover of mosses and lichens, sometimes knee deep, hides the holes and decayed wood, making access, whether for exploration or for logging, very slow and expensive. The accumulation of litter varies also with topography and moisture. Ascending the mountains along the combs or ridges, which are most thoroughly drained, less débris is found. In fact, some of the very steep, dry, and smooth ridges have little material covering the earth. In the hollows, however, where it is more moist, and in unburnt woods, wherever streams begin to form, the more constant moisture seems to preserve the material somewhat from decay. Here, too, the mosses grow more freely, and the condition found in the lowlands is approximated. In fact, the crossing of small water courses in the mountains is often as difficult as traveling in the lowlands.

Burnt areas are free from litter in proportion to the severity of the fire. The greater portion of the burnt areas on the Stilaguamish, the South Fork of the Sauk, Slate and Canyon creeks, and the Skagit Valley has little other litter than the fallen wood killed by the fires. A notable exception to this general condition is found at Monte Cristo, where merely the surface of the litter has been burned over, leaving abundant material to feed another fire.

Above the timber line the slopes are often so steep that litter can accumulate only in the hollows or among the heather and other mountain brush.

UNDERBRUSH AND YOUNG GROWTH.

A climate more favorable to the growth of underbrush or to the starting of young trees would be hard to find. In addition to the moist atmosphere, the soil is usually well watered, and besides this the branches of overtopping trees are usually so high that light and air penetrate abundantly and tend to prevent overshading. In consequence of these three favorable conditions, either underbrush or young trees abound wherever the old stock of trees has been thinned by age, wind, heavy snow, or cutting.

In the lower region are vine maple, willow, crab apple, hazel, dogwood, huckleberries, blackberries, and salal. In the mountains, reaching to the foot of the glaciers, where exposure is not too severe, are the mountain huckleberries, mountain ash, mountain maple, alder, devil's club, salmon berry, Ceanothus, azalea, heather, and juniper.

The influence of moisture on undergrowth in this region is notable. Wherever, away from the incumbrance of lingering snow, the earth is well supplied with moisture, the tangle of brushwood begins, even when well shaded by high trees. On the dry eastward slopes of the mountains, however, where moisture is less abundant, a slighter shading suffices to clear the ground of underbrush, and open views under the sparse woods become characteristic of this dry region. A transition toward this condition is noticeable in the intermediate region on the eastern tributaries of the Skagit above the canyon. Brush abounds

LOWER BENCH LAND IN SKAGIT VALLEY.

in this portion of the Skagit drainage, however, as a result of the fires which have overrun this region, especially at the time of the rush to Ruby Creek for gold, about seventeen years ago.

The abundance of brush and young growth among the timber will considerably increase the expense of logging and other forest work.

FOREST TREES.

Trees growing within the reserve.

Common name.	Botanical name.	Distribution.
Douglas spruce, red fir, or yellow fir.	Pseudotsuga taxifolia	The bench lands of the valleys and the lower mountain slopes.
Pacific arbor vitæ, or cedar.	Thuja plicata	Mixed with red fir and hemlock from river bottoms to lower mountain slopes.
Hemlock	Tsuga mertensiana	Common up to 4,000 feet.
Mountain hemlock	T. pattonii	Common above 4,000 feet.
Mountain cedar	Chamæcyparis nootkatensis.	On mountain slopes above 2,000 feet.
Sitka spruce	Picea sitchensis	Along streams up to an altitude of 2,000 feet.
Engelmann spruce	P. engelmanni	At high altitudes; small and difficult of access.
Amabilis fir (erroneously called larch).	Abies amabilis	On moist land and northern slopes up to 4, 000 feet.
Alpine fir, or balsam	A. lasiocarpa	On the higher slopes and summits—a small tree.
Silver fir, or rough-barked fir.	A. grandis	From the lowlands to an altitude of 5,000 feet.
White pine	Pinus monticola	Sparingly at medium altitudes, on bench lands and lower mountain slopes.
Yellow pine	P. ponderosa	Found only on the dry slopes of the Skagit Valley north of Lightning Creek.
Scrub pine	P. murrayana	Sparingly on dry bench lands near Darrington, abundantly on the slopes along Slate Creek and northward to the international boundary.
Whitebark or mountain pine.	P. albicaulis	Confined to high altitudes; sparsely distributed.
Alpine larch, or mountain tamarack.	Larix lyallii	Not uncommon along the summit of the Cascade Range from Cascade Pass northward.
Pacific yew, or yew	Taxus brevifolia	Common as an under tree on moist land up to an altitude of 3,000 feet.
Black cottonwood	Populus trichocarpa	Common along streams in lower altitudes.

Trees growing within the reserve—Continued.

Common name.	Botanical name.	Distribution.
Balm of Gilead	P. balsamifera	Occurs sparingly on the Upper Skagit and eastward.
Aspen	P. tremuloides	Slate Creek, northward and eastward in the Skagit drainage.
Paper birch, or white birch.	Betula papyrifera	In the Skagit Valley; abundant above Ruby Creek, rare below.
Oregon maple	Acer macrophyllum	Along streams below 2,000 feet.
Vine maple	A. circinatum	A large shrub or small tree, common below 3,000 feet.
Red alder	Alnus oregona	Common along streams in lower altitudes.
Bearberry, or chittam wood.	Rhamnus purshiana	Common on moist land in lower valleys as an under tree.
Western dogwood	Cornus nuttallii	On bench land in lower altitudes.
Oregon crab apple	Pyrus rivularis	Common on low, wet land along Skagit, Baker, and Nooksak rivers.

DISTRIBUTION.

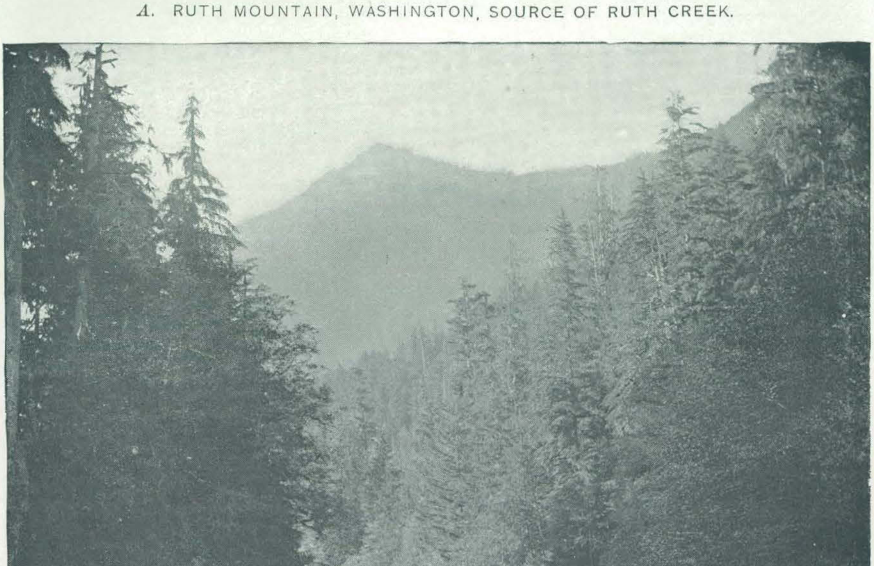
In the constantly watered portions of the lowlands the trees growing crowd into dense forests and push upward, often to a height of 300 feet. Where moisture is intermittent, as on gravelly bench land, or on thoroughly drained mountain ridges, less vigor is shown.

Ascending in altitude beyond certain limits, however, the greater precipitation is unable to balance the severity of the climate. Above perhaps 4,000 feet the growth becomes perceptibly shorter and more branched, the trunks more defective and twisted, and, near the upper limits of tree growth, isolated miniatures of the trees below are found rooting among the rocks, resisting the frequent storms and bearing as best they can the burden of snows that bend and frequently break them. Above 6,000 feet the trees grow in groups or singly, leaving the principal areas treeless. These areas, where earthy and not too long covered by snow, are occupied by the grasses, sedges, and heather that make their home above the forests wherever they can find earth to nourish them.

Other prominent features of the mountain view are the tracks of snow slides cut through the woods, down the steep, smooth slopes. These are often covered either by grass, weeds, or brush, and usually follow some water course or depression free from obstructing rocks, and converge in grassy basins at the heads of the mountain valleys. These basins are kept treeless by the accumulated snow, which lingers late

HOLDING DOWN A HOMESTEAD IN WASHINGTON.

A. RUTH MOUNTAIN, WASHINGTON, SOURCE OF RUTH CREEK.



B. NORTH FORK BRIDGE, WASHINGTON, ON TRAIL TO MINES.

Bridge on single log of red fir, north of Nooksack River.

into the summer, and whose receding edge is followed closely by green grass. The prospector looks to these basins for the only grass to be found for his horses.

EXPLANATION OF DISTRIBUTION CHART.

The distribution chart (Pl. LXXV) indicates only the habitat of the trees; it shows nothing of their density.

In the lower zone on the west side, while the Sitka spruce, the silver fir, the shingle cedar, the common hemlock, and the white pine occur in this belt, all are subordinated to the red fir. This being the most prominent tree, the belt is called the red-fir zone. The distribution of the red fir and the white pine here is considerably interrupted, some areas and bottoms being dominated by the Sitka spruce, and others, both in the bottoms and in the lower slopes, by the cedar.

In the second, or hemlock and white fir zone, covering the main slopes of the mountain spurs, hemlock, cedar, and white fir predominate, but these species are also found in the lower belt subordinate to the red fir, and the white fir continues into the belt above. Other trees also occur in the second belt, such as the Alaska cedar, which begins here and continues into the subalpine region above. On Slate Creek the scrub pine replaces to a great extent the hemlock and cedar, especially on the drier slopes. It is quite noticeable that in the southern portion of the reserve the cedar is more abundant than in the Upper Skagit, Baker, and Nooksak valleys. Large areas in this belt have been burned over, but most of the burns have been restocked with trees of the same species.

In the third, or alpine zone, which covers the summits of the main spurs and that of the main divide, the growth is usually very sparse; in fact, the greater portion of this area has no trees at all, being a barren surface of rock, snow, and ice. Groups of trees crowd closely to the foot of the glaciers and, in the more protected gulches, form dense forests. The trees joining to form this forest are usually the mountain hemlock, the alpine fir, the Engelmann spruce, and, in the lower portion, the amabilis fir. Mountain pine (*Pinus albicaulis*) and the alpine larch (*Larix lyallii*) do not form compact woods, but grow openly on exposed, grassy areas where snow lingers late into summer. Near the lower limit of this zone on the eastern side of the range, aspen, cottonwood, balm of Gilead, lodgepole pine, and Sitka spruce are occasionally seen.

DISTRIBUTION AND CLIMATE.

The transition from the heavy timber west of the mountains to the prairie east occurs within the reserve, and the changes in vegetation seem to coincide with changes of climate. No records of rainfall or temperature are at hand as a basis for defining the difference in climate, but several trips across the main divide and several views from high peaks while part of this region was covered by storms or by newly fallen snow are in evidence on this point. On September 15, from the mountain north of Ruby, opposite the mouth of Granite Creek, the region westward was seen to be covered with clouds shedding frequent rain. Eastward, however, the mountains were in view clear to the main divide. There were some clouds, but they were light and broken.

At Cascade Pass, August 31 and September 1, a snowstorm raged on the main divide, and rain fell at camp, 3 miles east of the divide. East of camp the clouds could be seen growing lighter and lighter as they stretched off in the distance, finally leaving blue sky on the eastern horizon.

On the western side of the mountains, during the frequent October storms, which shed snow upon the mountain tops and rain in the valleys, the higher clouds coming from the southwest enveloped the higher mountain tops, while return currents of broken clouds followed down the valleys, shedding intermittent showers as they passed. During this month the prevailing lower limit of the upper clouds approximately contoured the lower limits of the subalpine trees and kept the forest above loaded with snow and frost, while below this limit amabilis fir (*Abies amabilis*), hemlock (*Tsuga mertensiana*), and cedar (*Thuja plicata*) were moist but not frosted, and were seemingly in good condition to mature their season's growth of wood. With these phenomena of climate in mind one is prepared to discover great differences in vegetation, both in species and in the development of these species.

GENERAL DISTRIBUTION OF TREES.

Beginning in the alluvial bottoms west of the western limit of the reserve—say at Lyman, in the Skagit Valley—the forest consists on the lower bottom of a dense tangle of alder, vine maple, crab apple, devil's club, and ferns, among which are growing large trees of Sitka spruce, cedar, large-leaved maple, cottonwood, and, occasionally, silver fir. On the benches above this bottom is the principal timber in demand by the lumbermen, consisting principally of red fir, with a mixture of hemlock, cedar, and subordinate species. Ascending the mountain slopes the red fir disappears, and hemlock, amabilis fir, and cedar continue as rivals, usually to a height of some 4,000 feet. Then the amabilis fir predominates to the foot of the alpine species, and even mingles with those species, especially on the more earthy slopes. The Alaska or mountain cedar (*Cupressus nootkatensis*) is usually the first of the subalpine species to be seen in ascending the mountain. Then the mountain hemlock (*Tsuga pattonii*), the subalpine fir (*Abies lasiocarpa*); and the Engelmann spruce (*Picea engelmanni*) are found, and these continue to the foot of the glaciers and to the summits of the lower peaks, mingled there with the alpine larch (*Larix lyallii*) and the white-bark pine (*Pinus albicaulis*). Descending the eastern slope the

ROCK AND SNOW SLIDE, HANNIGAN PASS, WASHINGTON, FROM EAST SIDE.

VIEW OF DEVIL'S BACKBONE FROM COPPER QUEEN MINE, SHOWING SUBALPINE TREES STRUGGLING FOR EXISTENCE.

first indications of a change of species is usually found in the appearance of the service berry and the aspen. Soon afterwards comes the lodgepole pine, with a shorter growth of red fir than that common on the western slope. The red fir, commonly reaching a height of 300 feet in the Puget Sound country, is not seen east of the divide more than 100 feet high, and there evidently is of slower growth, has a shorter trunk, and is more knotty. The bark of this tree growing on the eastern slope appeared dark gray, almost black, while in the Sound country the usual color on the larger trees is a reddish yellow. On the eastern slope the amabilis fir and the hemlock become limited to the moister areas, leaving the dry ridges and benches to the lodgepole and yellow pine. The lodgepole pine soon gives way to the yellow pine in the lower altitudes, and the yellow pine in turn becomes reduced in density toward the Methow River, occurring only as scattered individuals, and at last leaving large areas in this valley entirely to grass.

EXCEPTIONS IN DISTRIBUTION.

The eastern portion of the Skagit River drainage above the canyon is a notable exception to the rule of distribution. Here are found considerable areas of scrub pine; and aspen, white birch, service berry, balm of Gilead, and even yellow pine are occasionally found mingled with other growth.

Coincident with this exception in distribution this region is found cut off from the Puget Sound country by the high and rugged spur that connects Mount Baker with the Cascade Range, and by reason of this obstruction to the storms of the Pacific the climate of this region undoubtedly approaches that of the eastern slope of the Cascade Range. It seems probable that close observations of rainfall may prove considerable variations in moisture, corresponding with the notable differences in plant distribution now to be seen not only between this portion of the Skagit drainage and the main western slope of the range, but also between the different valleys of the eastern slope, which seem to vary in the amount of moist atmosphere received during storms from the west, according to their exposure or shelter by the varying topography of the main range.

DETAILED DESCRIPTIONS.

PSEUDOTSUGA TAXIFOLIA. (Red fir.)

This is the species most sought by lumbermen in the Puget Sound country. It is not abundant within the limits of the proposed reserve, and is confined to the valleys, principally to the bench land along the streams. One of the largest trees found within the reserve was on well-watered soil about 300 feet from the Stilaguamish River and about 30 feet above the stream. The top of the stump of this tree averaged 82 inches in diameter and was 9 feet above the ground. The top of the tree was broken and lost at 245 feet above the stump, where the diameter was 9 inches. The first limb was 100 feet above the stump. At this point the diameter of trunk was 4 feet 3 inches. All trunk measurements are inside bark. The bark on the stump was 3½ inches thick; at 100 feet above the stump 2 inches, and at 245 feet above the stump one-half inch. The number of annual rings on the stump was 377. During the last one hundred years 8⅝ inches were added to the radius; during the two earlier periods of one hundred years 10½ inches and 11½ inches, respectively, and during the first seventy-seven years 10½ inches. This tree was perfectly sound. It contained, approximately, 20,000 feet B. M. of log timber, marketable on the Sound, or 25,000 feet B. M. of quality marketable at eastern mills. This tree was crowded by other inferior trees, but was not injured by them.

A small tree of the same species, crowded by others of smaller size about 20 feet apart, was measured. This was on dry, gravelly bench land near Darrington. Its diameter on top of stump, 8 feet above ground, was 21 inches, with 127 annual rings. At the first limb, 90 feet above the stump, the diameter was 13 inches. The total height was 170 feet.

In marked contrast with such crowded growth is the sparse growth to be seen after severe and extensive fires, an example of which was found on similar land in the Nooksak Valley below Keese. One stump here had a diameter of 22 inches at 30 inches above the ground. At 16 feet higher the diameter was 18 inches. The total height of the tree was 83 feet. The number of rings on the stump was 31. It was not crowded, except by brush. The accretion on the radius during the last ten years was 96 millimeters; during the prior ten years, 112 millimeters; during the first year, 4 millimeters. All measurements of trunk were inside of bark. The bark averaged 12 millimeters thick.

Another tree in the same locality, but crowded—the land being better stocked—measured on top of the stump, 30 inches above the ground, 23 inches in diameter, with 50 annual rings. The accretion on the radius during the last ten years was 30 millimeters; the earlier accretions, by periods of ten years, were, respectively, 80, 70, 85, and 25 millimeters. The height to the first limb was 35 feet, and the total height was 126 feet.

A number of trees cut for timber were measured in the usual manner for stump and top scaling. These grew on the alluvial bottom of the Skagit River, crowded by similar trees, with a few smaller hemlock and cedar mingled, averaging 30 feet apart. On the stump, 7 feet above the ground, the bark was 4 inches thick and the diameter was 70 inches, with 253 annual rings.

BOTTOM LAND IN SKAGIT VALLEY.

VIEW BETWEEN RUTH MOUNTAIN AND TOMMY HIGH, WASHINGTON; TIMBER LINE.

SUBALPINE FOREST, RUTH MOUNTAIN.

The accretion on the radius during the last twenty-five years was 38 millimeters; the earlier accretions, by periods of twenty-five years, were, respectively, 47, 67, 100, 102, 105, 120, 86, 95, and 120 millimeters, and during the first three years the accretion was 12 millimeters and the bark was 2 inches thick. At 104 feet above the stump the diameter was 45 inches. There were 209 annual rings.

The accretion on the radius during the last twenty-five years was 34 millimeters; the earlier accretions, by periods of twenty-five years, were, respectively, 40, 45, 56, 65, 84, 96, and 110 millimeters, and during the first nine years the accretion was 45 millimeters. At 179 feet the above stump had a diameter of 35 inches, with 167 annual rings. At this point the bark was 1½ inches thick. The accretion on the radius during the last twenty-five years was 34 millimeters; the earlier accretions, by periods of twenty-five years, were, respectively, 44, 55, 70, 83, and 89 millimeters, and during the first seventeen 68 millimeters. At 195 feet above the stump the bark was 1⅝ inches thick, the diameter was 30 inches, and there were 153 annual rings. The accretion on the radius during the last twenty-five years was 34 millimeters; the earlier accretions, by periods of twenty-five years, were, respectively, 43, 62, 67, 80, and 88 millimeters, and during the first three years 10 millimeters. The total height of this tree was 315 feet.

Two 52-foot logs were utilized from this tree, scaling 14,000 feet B. M., and 5,745 feet B. M. of log timber marketable at eastern mills were left in the top, making a total of 19,745 feet B. M. of log timber in the tree.

Another red fir under similar conditions was measured. On its stump, 6 feet above the ground, the bark was 2 inches thick, the diameter was 56 inches, and there were 245 annual rings. The accretion on the radius during the last twenty-five years was 20 millimeters; the earlier accretions, by periods of twenty-five years, were, respectively, 28, 30, 55, 50, 88, 110, 110, and 108 millimeters, and during the first twenty-one years 110 millimeters. At 104 feet above the stump the bark was 1¼ inches thick, the diameter was 40 inches. There were 199 annual rings. The accretion on the radius during the last twenty-five years was 35 millimeters; the earlier accretions, by periods of twenty-five years, were, respectively, 38, 43, 53, 52, 80, and 97 millimeters, and during the first twenty-four years 115 millimeters. At 163 feet above the stump the bark was 1½ inches thick, the diameter was 30½ inches, and there were 172 annual rings. The accretion on the radius during the last twenty-five years was 30 millimeters; the earlier accretions, by periods of twenty-five years, were, respectively, 39, 40, 55, 48, and 88 millimeters, and during the first twenty-two years, 90 millimeters. The total height of this tree was 270 feet, and the height of the first limb was 165 feet.

Two logs, each 52 feet long, were utilized, scaling 11,600 feet B. M. In falling, 1,900 feet B. M. were broken, and 850 feet B. M., marketable at eastern mills, were left on the ground.

A half acre of red-fir stump land was staked off and scaled. This tract was on the Skagit bottom, some 2 miles southwest of Lyman, elevated about 30 feet above the river. The soil consisted of fine sediment, with enough sand and gravel to make it porous. Fourteen timber trees were cut on this half acre. The material utilized scaled 62,668 feet B. M.; the material broken in falling, 8,084 feet; and the material marketable at eastern mills, left unbroken, 13,175 feet additional. Ten trees, marketable at eastern mills, were left uncut on this half acre, estimated to contain 12,500 feet B. M. Adding these items, we find a total on the half acre of 96,427 feet B. M.

One tree, grown at a much higher altitude (about 2,000 feet), and crowded by large cedars, was measured. This was on Beaver Creek, Whatcom County, in well-watered alternating gravel and loam. On the stump, 5 feet above ground, were 212 annual rings, with a diameter of 45 inches, and bark 5 inches thick. During the last one hundred years the accretion on the radius was 6 inches; during the prior one hundred years, 13 inches, and during the first twelve years 3½ inches. The height to first limb was 117 feet, where the diameter was 22½ inches, outside of bark; the total height was 206 feet above ground.

THUJA PLICATA Don. (Cedar.)

This tree, next in demand to the red fir, is sought principally for shingles, made from it for distant markets, and for split boards, used locally. It abounds on all well-watered bottoms and lower mountain slopes. It reaches great age, and is often seen standing among younger growths as a survivor of a former generation. Near Buck Creek, on the Everett and Monte Cristo Railway, a stump was seen measuring 97 inches in average diameter. On this stump 1,137 annual rings were counted, although the wood in the center, a foot in diameter, was too rotten to show the rings.

A medium-sized tree was measured near the mouth of Bowlder Creek, on the North Fork of Nooksak River, standing in fertile soil at about high-water mark, and crowded by other cedar and by large alder. The stump, at 3 feet high, had an average diameter of 45 inches, with 209 annual rings. The accretion on the radius during the last twenty-five years was 101 millimeters; the earlier accretions, by periods of twenty-five years, were, respectively, 62, 102, 98, 87, 73, 30, and 22 millimeters; and during the first nine years, 6 millimeters. At 32 feet above the stump the diameter was 26½ inches and the bark 30 millimeters thick. At 64 feet above the stump the diameter was 23 inches and the bark 20 millimeters thick. At 100 feet above the stump the diameter was 15 inches and the bark 20 millimeters thick. At 100 feet above the stump the accretion on the radius during the last twenty-five years was 50 millimeters; the earlier accretions, by periods of twenty-five years, were, respectively, 38 and 68 millimeters; and

A TIMBER CLAIM.

A MOUNTAIN MEADOW, RUTH MOUNTAIN, WASHINGTON, NORTHWEST FROM HANNIGAN PASS VICINITY.

during the first thirteen years, 35 millimeters. The first limb was 50 feet above the stump. The total height above ground was 154 feet.

Another cedar was measured in the Nooksak Valley, in fertile and well-watered soil at the foot of a hill, from which the few large surrounding trees of red fir, white spruce, and cedar had been cut many years ago. The total height of this tree was 164 feet. The first live limb was 60 feet above the ground.

Measurements of sections on cedar in Nooksak Valley.

	Height of section above stump.									
	0. 0	8′ 8″	a17′ 4″	26′	34′ 10″	43′ 6″	52′ 2″	60′ 10″	69′ 6″	78′ 2″
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Thickness of bark	5 to 13	20 to 40	......	25 to 40	15 to 40	30 to 40	30 to 40	15 to 40	15 to 40	20 to 35
Accretion last 25 years	190	102	......	60	40	45	50	50	52	45
Accretion prior 25 years	143	108	......	77	56	60	65	58	70	70
Do	85	67	......	63	54	50	60	56	72	70
Do	118	90	......	80	67	72	70	67	67	83
Do	60	53	......	49	53	47	65	67	70	63
Do	55	42	......	42	48	50	50	56	43	38
Do	53	48	......	55	60	72	50	45	22	......
Do	69	60	......	60	74	68	50	28	......	......
Do	50	34	......	50	45	12	......	......	......	......
Do	38	39	......	31	6	......	......	......	......	......
Do	27	38	......	......	......	......	......	......	......	......
Accretion first 15 years	25	4	......	......	......	......	......	......	......	......
Total radius	913	685	......	567	503	476	460	427	396	369
Annual rings..No.	290	279	......	245	231	207	197	187	175	150

a Large knot, making measurement impracticable.

TSUGA MERTENSIANA (Bong.) Carr. (Hemlock.)

This species is common everywhere below 4,000 feet. In Monte Cristo, at an elevation of 2,800 feet, a tree grown near a mountain stream was measured. On the stump, 6 feet above the ground, the bark was 1½ inches thick, the diameter inside of bark was 52 inches, and there were 479 annual rings. The accretion on the radius during the last one hundred years was 152 millimeters; the earlier accretions, by periods of twenty-five years, were, respectively, 145, 140, and 133 millimeters; and during the first seventy-nine years, 77 millimeters.

At 87 feet above the stump the diameter was 36 inches, and at 129 feet 28 inches, with 294 annual rings. At 171 feet above the stump the top was broken off and lost. The diameter at this point was 12 inches.

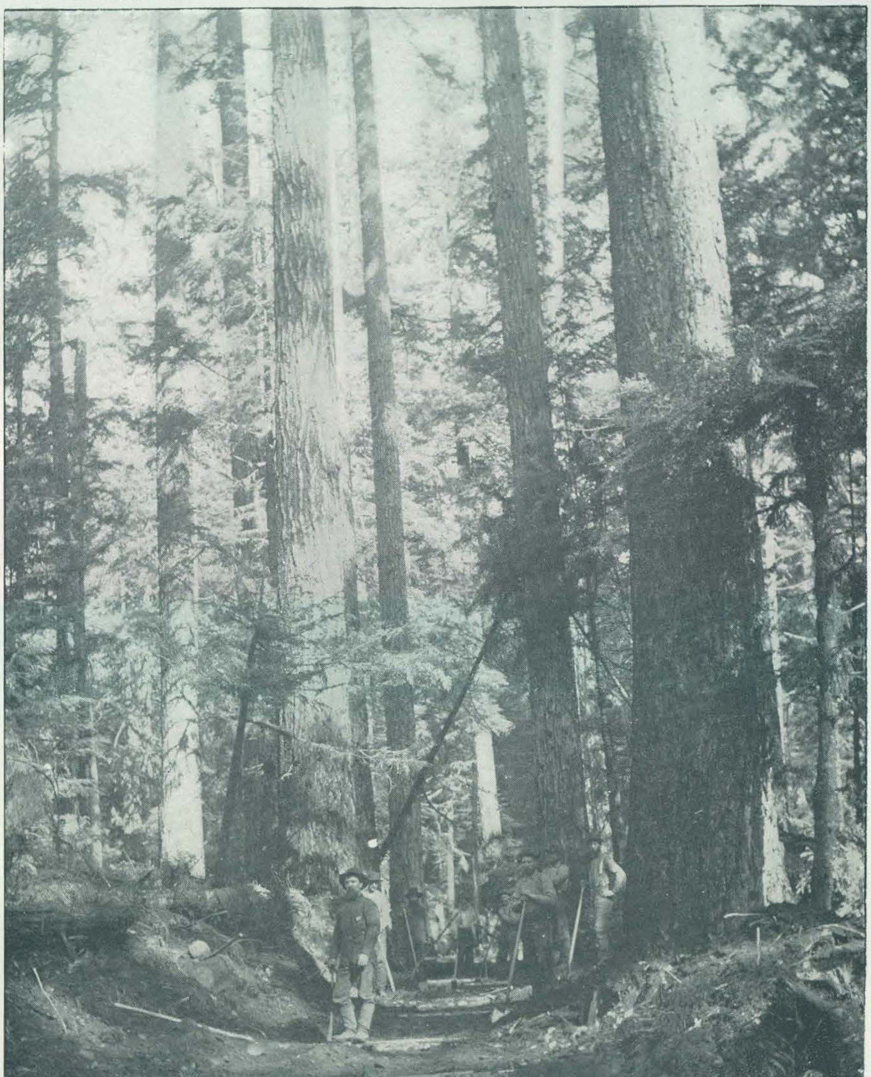
Another tree of this species, grown near the 18-mile post on the Hannegan trail, was measured. It grew near the limit of continuous forest, about 50 feet from the North Fork of Nooksak River and about 15 feet above the water. It was crowded by 12 other hemlock, from 9 to 48 inches in diameter, within a radius of 60 feet. This tree was cut into 8-foot blocks and measured as follows:

The stump was 3½ feet above ground; the total height of the tree was 137½ feet; and the volume of bark was approximately 29 cubic feet.

A small tree was measured in the valley of Beaver Creek, Whatcom County. On the stump, 2 feet above ground, the average diameter inside of bark was 16½ inches, with 217 annual rings. The bark was three-fourths of an inch thick. The accretion on the radius during the last one hundred years was 95 millimeters; during the prior one hundred years, 82 millimeters; and during the first seventeen years, 33 millimeters. The first limb was 33 feet above the stump, where the diameter was 13 inches. The total height was 122 feet. Eleven hemlock and 2 red fir, 7 to 26 inches in diameter, surrounded the tree within a radius of 30 feet. The soil was wash from the mountain side, about one-half sand.

Another tree in the same vicinity was 15 inches in diameter on stump, 2 feet above ground, with 153 annual rings; the bark was three-fourths of an inch thick. The first limb was 66 feet above stump, where the diameter was 9¼ inches inside of bark. The total height of this tree was 113 feet above ground. It was crowded on all sides by hemlock of similar size.

RED FIR; SCENE IN McDOUGALL & JACKSON CAMP, ARLINGTON, WASHINGTON.



MAKING SKID ROADS IN RED FIR NEAR SHELTON, WASHINGTON

Measurements of sections on hemlock in Nooksak Valley.

	Height above stump (feet).								
	0.0	8	16	24	32	40	48	56	64
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Thickness of bark ..	*a* 17	15	15	14	14	15	15	15	15
Accretion on radius:									
Last 25 years ...	......	33	39	39	32	36	35	30	30
Prior 25 years ..	......	24	23	25	21	23	22	21	20
Do	......	30	26	28	25	24	22	23	27
Do	......	32	32	32	28	26	23	26	20
Do	......	35	24	20	18	21	22	25	25
Do	......	20	23	20	21	22	28	36	32
Do	......	25	31	27	29	37	40	28	10
Do	......	40	45	38	34	15	2	......	....
Do	......	13	......	......	......	......	......	......	....
Total	320	252	243	229	208	205	194	189	164
Annual rings..No ..	......	206	200	195	190	181	176	170	156

	Height above stump (feet).								
	72	80	88	96	104	112	120	128	134
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Thickness of bark ..	14	13	12	11	9	6	6	2	Top.
Accretion on radius:									
Last 25 years	26	28	32	25	25	19	24	15	....
Prior 25 years ..	21	25	26	22	20	26	16	......	....
Do	29	23	31	34	37	21	2	......	....
Do	27	33	20	23	5	......	......	......	....
Do	24	20	16	......	......	......	......	......	....
Do	30	13	......	......	......	......	......	......	....
Do	......	......	......	......	......	......	......	......	....
Do	......	......	......	......	......	......	......	......	....
Do	......	......	......	......	......	......	......	......	....
Total	157	142	125	104	87	66	42	15	....
Annual rings..No ..	147	136	120	100	81	68	52	16	....

a Stump was hollow.

PICEA SITCHENSIS (Bong.) Traut. and Mayer. (Sitka spruce, white spruce.)

A large tree of this species, grown along the Stilaguamish River, near Gold Basin, was measured. On the stump, 8 feet above the ground, the bark was 1 inch thick. The diameter inside of bark was 67½ inches, with 242 annual rings. The accretion on the radius during the last one hundred years was 13¾ inches; during the prior one hundred years 15¾ inches, and during the first forty-two years 3½ inches. At 35 feet above the stump the diameter was 52 inches, with 203 annual rings. The accretion on the radius during the last one hundred years was 10 inches, during the prior one hundred years 17 inches, and during the first three years three-eighths of an inch. At 53 feet above the stump the diameter was 49 inches, with 191 annual rings. The accretion on the radius during the last one hundred years was 11 inches, and during the first ninety-one years 14 inches. At 166 feet above the stump the diameter was 18¾ inches, with 117 annual rings. Here the accretion on the radius during the last one hundred years was 8¼ inches, and during the first seventeen years 2 inches. The total height of the tree was 240 feet. It contained, approximately, 13,240 feet B M. of log timber.

Another tree grown on the Skagit bottom was measured. On the stump 8 feet above ground the bark was 2 to 5 millimeters thick. The diameter inside of bark was 68 inches, with 239 annual rings. During the last twenty-five years the accretion on radius was 100 millimeters. The earlier accretions, by periods of twenty-five years, were, respectively, 118, 117, 97, 110, 105, 86, 55, and 53 millimeters, and during the first fourteen years 25 millimeters. Another section, at the first limb, was measured, but as the height of the section above the stump was not recorded its measurements have no value. Log timber marketable at eastern mills, scaling 7,655 feet B. M., was left in the top.

Another tree of this species in same vicinity was measured. The bark of this tree was in marked contrast with the former, being 2½ inches thick and corky. On the stump, 6 feet above the ground, the diameter was 85 inches, with 247 annual rings. The accretion on the radius during the last twenty-five years was 55 millimeters. The earlier accretions, by periods of twenty-five years, were, respectively, 93, 120, 122, 103, 152, 174, 119, and 75 millimeters, and during the first twenty-two years 50 millimeters. At 52 feet above the stump the diameter was 10 inches inside of the bark, which was 40 millimeters, or 1½ inches, thick, and there were 206 annual rings. The accretion on the radius during the last twenty-five years was 38 millimeters. The earlier accretions, by periods of twenty-five years, were, respectively, 50, 78, 90, 90, 142, 128, and 130 millimeters, and during the first six years 20 millimeters.

A log from the butt, 52 feet long, scaling over 12,000 feet B. M., was utilized, and material marketable at eastern mills, scaling 6,236 feet

SKIDDING RED FIR.

LOGGING RED FIR.

B. M., was left on the ground. The total height of this tree was not determinable, as the top was broken and lost at a height of 240 feet above stump, where the diameter was 4 inches. The height to first limb was 62 feet.

PINUS MONTICOLA Dougl. (White pine.)

A small tree of this species, grown at an elevation of about 2,000 feet, on Beaver Creek, Whatcom County, was measured. On the stump 2 feet above ground the average diameter was 21 inches, with 157 annual rings.

The bark was one-half inch thick. During the last one hundred years 7¾ inches were added to the radius, and during the prior fifty-seven years 2⅞ inches. The first live limb was 66 feet above the stump, where the diameter was 13.2 inches outside of bark. The total height of the tree was 143 feet above ground. It was surrounded by hemlock, white fir, white pine, and cedar. Thirty trees 6 to 23 inches in diameter stood within a radius of 30 feet.

ABIES AMABILIS (Loud) Forb. (Fir, larch.)

A tree of this species was measured which was grown near Monte Cristo at an altitude of 2,700 feet. At 12 feet above the ground the diameter inside of bark was 29⅝ inches. The bark was 1⅛ inches thick. At 65 feet above ground the diameter inside of bark was 21 inches, with 136 annual rings. The bark at this point was five-eighths of an inch thick. Here during the last one hundred years 5⅝ inches were added to the radius. At 77 feet above ground was a diameter of 19½ inches, with 130 annual rings. During the last one hundred years 5¼ inches were added to the radius at this point. The bark here is five-eighths of an inch thick. The first live limb was 106 feet above ground. At 125 feet above ground the diameter was 11½ inches inside of bark, bark being one-half inch thick. The total height of this tree was 161 feet. It was crowded by white fir and hemlock of like size.

A tree growing at an elevation of 250 feet near Marblemount was also measured. On the stump, 9 feet above ground, the diameter was 24½ inches and there were 93 annual rings. At 15 feet above ground the diameter was 24 inches and there were 83 annual rings. At 39 feet above ground the diameter was 17½ inches and there were 56 annual rings. At 123 feet above ground the diameter was 10 inches and there were 36 annual rings. The top was broken and lost at 148 feet above ground. The average thickness of the bark was one-half inch.

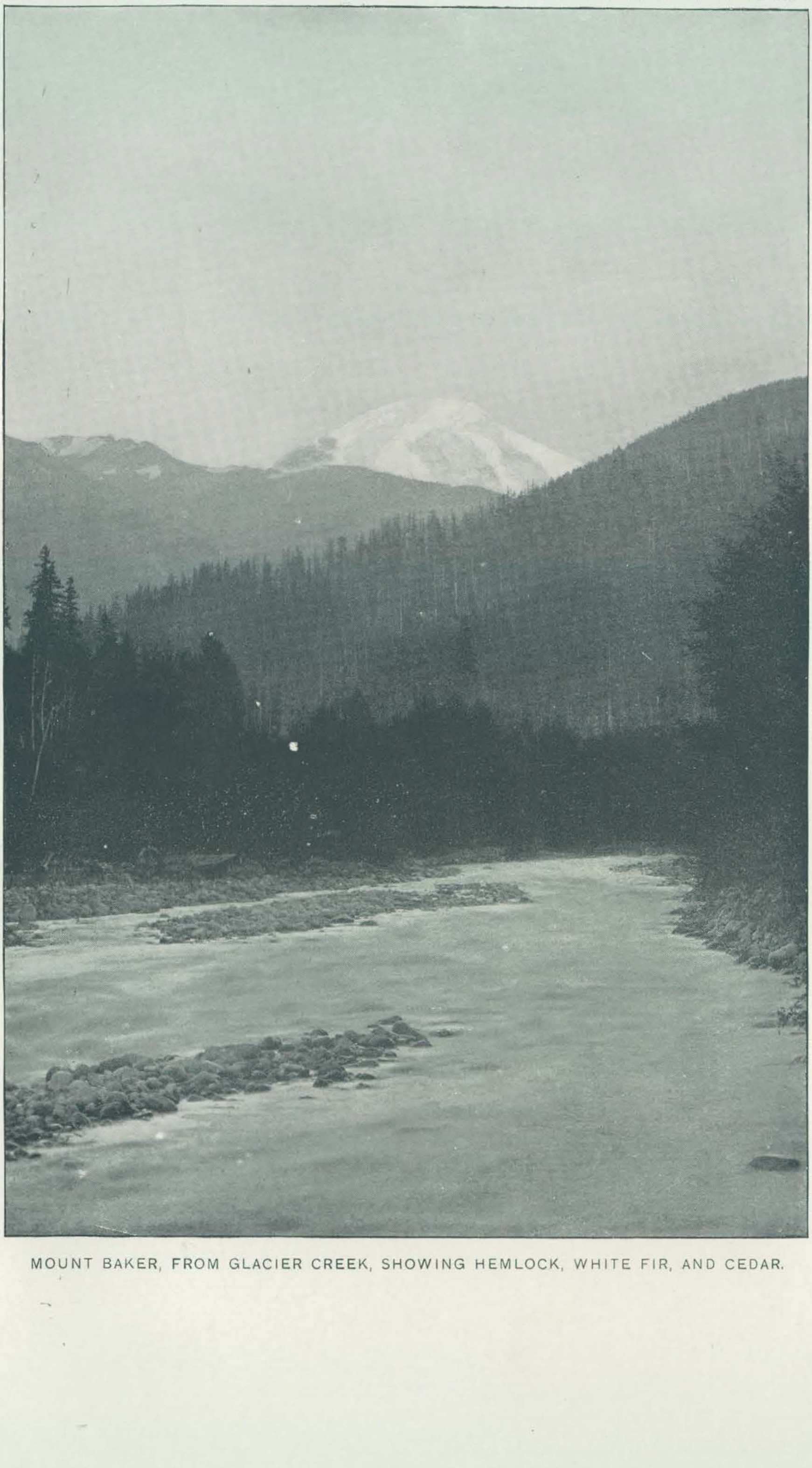
Near the 18-mile post on the Hannegan trail, at an elevation of some 4,000 feet, near the limit of continuous forest, another white fir was cut into blocks 4 feet long and measured. It was perfectly sound except at 104 feet, where it was just beginning to rot.

The measurements of this tree are as follows:

Measurements of sections on amabilis fir.

Height above stump.	Thickness of bark.	Accretion on radius.									Radius.	Diameter.	Number of rings.
		Last 25 years.	Prior 25 years.	Prior 25 years.	Prior 25 years.	Prior 25 years.	Prior 25 years.	Prior 25 years.	Prior 25 years.	First 13 years.			
Feet.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*In.*	
0	11	38	40	39	14	22	30	50	24	20	257	20¼	213
4	12	13	35	38	31	14	26	34	50	8	240	19¾	198
8	12	25	34	41	23	16	24	35	40	......	238	18¾	191
12	12	19	33	37	26	17	32	50	19	......	234	18¼	183
10	15	19	34	38	26	22	36	51	6	......	232	18⅛	177
20	16	15	37	47	37	13	29	50	......	......	228	17⅞	174
24	15	18	35	36	30	26	41	40	......	......	226	17¾	171
28	12	15	40	50	42	27	34	16	......	......	224	17½	168
32	12	15	29	34	43	34	44	20	......	......	219	17¼	165
36	12	13	33	36	42	44	44	3	......	......	215	16⅞	152
40	10	17	35	46	48	32	33	......	......	......	211	16½	141
44	10	15	49	50	37	29	25	......	......	......	205	16⅛	137
48	10	20	46	54	38	34	7	......	......	......	199	15⅝	130
52	11	17	45	51	47	34	......	......	......	......	194	15¼	124
56	10	12	44	55	55	19	......	......	......	......	185	14½	119
60	10	12	51	51	53	3	......	......	......	......	170	13⅜	102
64	9	14	43	55	47	......	......	......	......	......	159	12½	91
68	9	17	52	61	28	......	......	......	......	......	158	12⅜	85
72	9	17	45	63	23	......	......	......	......	......	148	11⅝	82
76	8	18	47	60	14	......	......	......	......	......	139	11	80
80	8	18	46	63	4	......	......	......	......	......	131	10¼	77
84	7	20	42	60	......	......	......	......	......	......	122	9⅝	73
88	8	22	46	49	......	......	......	......	......	......	117	9⅛	69
92	7	26	58	36	......	......	......	......	......	......	120	9⅜	64
96	7	22	51	25	......	......	......	......	......	......	98	7⅝	59
100	7	23	47	20	......	......	......	......	......	......	90	7	57
104	6	18	58	3	......	......	......	......	......	......	79	6¼	52
108	6	22	48	......	......	......	......	......	......	......	70	5½	47
112	6	19	38	......	......	......	......	......	......	......	57	4½	42
116	5	22	29	......	......	......	......	......	......	......	51	4	38
120	5	21	15	......	......	......	......	......	......	......	36	2¾	33
124	4	23	......	......	......	......	......	......	......	......	23	1¾	24
128	3	11	......	......	......	......	......	......	......	......	11	⅞	10
a 129	......	......	......	......	......	......	......	......	......	......	......	......	......

a Top of tree broken and lost at one-half inch diameter.



MOUNT BAKER, FROM GLACIER CREEK, SHOWING HEMLOCK, WHITE FIR, AND CEDAR.

The stump of this tree was originally 6 feet above the surface of the ground, but 3 feet was buried by wash of bowlders and gravel from a mountain torrent near by. Within a radius of 55 feet were 16 trees of white fir and hemlock, 11 to 29 inches in diameter, and 22 trees of white fir, 2 to 6 inches in diameter and from 12 to 35 feet high.

Another tree, grown on Beaver Creek at an altitude of about 2,000 feet, was measured. On the stump, 2 feet above the ground, the diameter was 16½ inches, and there were 127 annual rings. The first limb was 99 feet above the stump, where the diameter was 9 inches inside of bark. The total height was 152 feet; the bark averaged one-half inch thick. This tree was killed through overcrowding by hemlock, amabilis fir, and red fir.

HEMLOCK AND FIR MIXED.

As these two species are commonly found growing together, an acre of such stock, on the western boundary of the reserve, between the North Fork and the Middle Fork of Nooksak River, at an elevation of 3,000 feet, was carefully estimated. On this acre there was no timber considered marketable on the stump, but 40 timber trees, averaging 400 feet each, or 16,000 feet B. M., on the acre were suitable for market at eastern mills. Of this amount one-third, or 5,300 feet, consisted of hemlock.

The largest trees were 30 inches in diameter and 100 feet high. On this acre there were also 50 trees, 30 fir and 20 hemlock, 4 to 10 inches in diameter and 30 to 70 feet high, and 100 young fir and hemlock 5 to 10 feet high.

This acre was chosen as representative (except that cedar was lacking) of by far the greater area of wooded land within the reserve. The hemlock and white fir, which have little or no commercial value at present, cover the greater portion of the mountain slopes and form a resource which, if preserved, will some day be of much value.

In addition to the above list of species which are now, or promise soon to be, of commercial importance, the following will have more or less value, greatly dependent on their accessibility:

Chamæcyparis nootkatensis (Lamb.) Spach., mountain cedar or Alaska cedar.—This tree approaches the common cedar in size, but is more branched and more often crooked in the lower trunk. The special value of this wood will compensate somewhat for its difficulty of access.

Tsuga pattonii (Jeff.) Coville, mountain hemlock.—This tree sometimes reaches 4 feet in diameter and 100 feet in height, but is usually knotty and twisted from exposure.

Larix lyallii Parl., mountain tamarack.—This tree, while of some value for forest and mining timber, is too rarely a timber tree to become of commercial importance. The largest of this species seen was 22 inches in diameter and 75 feet in height.

Pinus albicaulis Engelm., white-bark pine.—This is also an alpine tree, short, with many branches, and frequently unsound. The largest seen was 24 inches in diameter and 40 feet high.

Picea engelmanni Engelm., Engelmann spruce.—Small and limby; is not abundant.

Pinus murrayana Balf., lodgepole pine.—This, in the eastern part of Whatcom County, is usually tall and straight. The largest trees seen were 16 inches in diameter and 90 feet high.

Abies lasiocarpa (Hook.) Nutt., balsam of the mountains.—Quite bushy, and unimportant in the present market for timber.

DEFECTIVE TIMBER.

The usual causes operate here also to make defects in the timber, the principal of which are age and overcrowding. The imperfect maturing of wood, caused by the shortness of the growing season, and the bending and breaking by snow and snow slides affect the trees of the upper slopes. All the causes of defective timber are most active in the higher altitudes. It is commonly said that there is no good timber in the mountains except the mountain cedar. An attempt was made to get the lumber at Monte Cristo for the concentrator and other buildings from the hemlock and white fir of the vicinity, but the effort was abandoned, and lumber, and even fuel, was brought from the lower country.

The forest of this region is especially defective from old age and overcrowding. Northward, however, where areas of younger trees are frequently found, there is promising timber in these two species, though now in little or no demand.

ESTIMATES OF TIMBER.

The usual estimates of standing timber in the Puget Sound country cover the red fir that will square 15 inches, or 22 inches in diameter, and such spruce, cedar, and hemlock as may be growing among it of similar size and good quality. These estimates exclude entirely very large and heavily wooded areas on the mountain slopes and in the higher valleys, and include only the best timber in the lower and more accessible valleys.

Puget Sound lumbermen will no doubt be astonished to learn that 13,000 million feet of log timber has been estimated in this region where they say there is none. To the lumber market of to-day this estimate will seem practically an absurdity, but to those who study these forests some terms are necessary to express the amount of material in them. Cubic feet being as yet unfamiliar, the estimate of the unmarketable material was made in board measure, but on the basis of eastern cuttings; that is, to include all timber that would make a log 8 inches at small end, 12 feet long, and would scale two-thirds of a full scale.

MONTE CRISTO; VIEW OF THE NEEDLES FROM POODLEDOG PASS, SHOWING DEFECTIVE TIMBER.

The great difference in size between the log timber used on the Sound and that used in Michigan, Wisconsin, and Minnesota is illustrated by the statement that within the 3,000 square miles on the western slope of the reserve, where the Sound cruisers would find only some 2,000 million feet suitable for their market, probably but 400,000,000 feet B. M. of this being salable to-day on the stump at 25 cents per thousand, an estimate to include 8-inch log timber finds nearly 14,000 million feet.

The difference between these figures, or 12,000 million feet B. M., with the roughly estimated 2,350,000 cords of hemlock bark and 5,000 million cedar shingles (included in estimate of log timber), represents a resource of no market value to-day and of questionable availability for the future, although it seems surprising that while so much enterprise is engaged in prospecting for mines and thus seeking to develop unknown resources, the possibilities of this material should be overlooked.

Doubtless all who have so far considered the question of cutting this material have decided that present prices and freight rates were prohibitory. While changes in these factors may be necessary, other considerations, such as broad and economic systems of operating in this mountainous and inaccessible region and the utilization of material now usually wasted, may render practicable in the future a large and permanent industry in this otherwise waste region.

In considering the chart which shows the location of timber within the reserve (Pl. LXXV), it should be borne in mind that the portions most heavily timbered and those on which the timber is most marketable are the best adapted to agriculture, and have been recommended in this report for withdrawal on that account. The 400,000,000 feet of timber now salable is on these lands. The timber that would probably sometime be available by the present methods of noncooperative lumbering is about 10,000 million feet, and covers only the more uniform slopes of the mountain spurs. Still, outside of or above these areas there are nearly 4,000 million feet that may never be cut with profit, unless for local use, such as mining.

The difficulty of floating logs on these mountain streams will render a comprehensive system of logging necessary. The logs could be taken from most, if not all, the basins by either flumes or electric railways, to which the logs could be brought from the stumps on the mountain sides by chutes or tramways; but the 3,000 million to 4,000 million feet lying outside the main basins are uncertain of profitable access even in the future. Cutting this timber will certainly not be profitable until the demand and prices for lumber are greatly increased. A very important consideration in the economy of these forests is the fact that small, independent operations, such as are usually carried on by lumbermen, would probably be unprofitable, because the smaller amount to be taken out would require a road or system of transportation that would cost perhaps as much as a road or system that would carry all there is in the valley. It is noticeable also that other than the present methods of transporting logs from the stump must be employed when knotty timber comes to be used, for only straight and smooth logs can be dragged over the skidding roads now used, which are made of cross logs bedded in the earth and greased on top.

FIRES.

The average moisture of the climate may give the impression that this forest is not liable to fires, but the occurrence of severely burnt areas testifies to the contrary. Although the season of 1897 has been exceptionally damp, 21 fires were found burning during the work of the examination, as follows:

1. Near Buck Creek, east of Perry Creek station, on the Everett and Monte Cristo Railway, July 29, a fire had just started near the track, evidently set by a locomotive that passed a few minutes before.

2. On the North Fork of Sauk River, about 5 miles from Indian Pass, August 15, there was an unextinguished camp fire eating slowly through the moss and litter.

3. On sec. 10, T. 32 N., R. 8 E., there was a fire in deep moss and litter on the border of a slashing in heavy and valuable red fir. It had evidently been set in the slashing for the purpose of clearing, although no one could be found watching the fire. It had acquired a large frontage and was eating rapidly into the trees, which were dry and combustible. Several families were living in the woods within 2 miles of this fire.

4. From Whitechuck Mountain, August 18, a large fire was seen raging around a peak, S. 60° W., not far from Silverton.

5. August 24, on sec. 29, T. 33 N., R. 10 E., there was a fire along a road on the border of fine young red fir.

6. August 29, on the mountain in the angle between Big Creek and Cascade River there was a fire in hemlock and cedar.

7. August 29, on the Cascade wagon road near Perleys, very near men at work on the State road, there were two unextinguished camp fires eating into the moss and spreading slowly.

8. August 29, 1½ miles above the forks of Cascade River there was an unextinguished camp fire in rotten hemlock.

9. August 30, on the North Fork of Cascade River, about 1 mile west of Gilbert Landre's, a fire had recently burned over about 5 acres and was still holding in moss and decayed vegetation.

10. August 30, near the summit of Cascade Pass, a fire that had burned over nearly 100 acres still lingered in moss, although mostly extinguished by rain.

11. August 30, on the very summit of the Cascade Pass, two fires were eating through groups of hemlock and fir.

A. VIEW SOUTHEAST FROM HANNIGAN PASS, WASHINGTON.

B. VIEW NORTHEAST FROM HANNIGAN PASS, WASHINGTON, SHOWING SNOW SLIDE.

BASIN RECEIVING SNOW SLIDES EAST OF HANNIGAN PASS, WASHINGTON.

12. September 5, near the head of the North Fork of Bridge Creek there was a fire left in charcoal making.

13. September 8, on Rattlesnake Creek, there were over 2,000 acres recently burned, and fires remaining in places.

14. September 10, on Slate Creek, near the mouth, some 500 acres had been burned and fire was not yet extinguished.

15. September 14, on south side of Ruby Creek, near mouth, some 200 acres had been burned over, and fire not yet extinguished.

16. September 17, on Lightning Creek, above the canyon, there were found some 2,000 acres burned, and fire not yet extinguished.

17. September 14, on sec. 31, T. 36 N., R. 11 E., there was a fire, escaped from slashing.

18. September 29 and October 4, on north bank of Sand Creek, on or near sec. 19, T. 37 N., R. 9 E., a fire had escaped from a camp.

19. October 3, on sec. 35, T. 38 N., R. 9 E., there was a fire in moss, muck, and roots, started by boys burning a yellow jacket's nest.

20. October 5, on sec. 11, T. 36 N., R. 8 E., there was an unextinguished camp fire.

21. October 27, an unextinguished camp fire was burning in a tree 2 miles east of the 20-mile post on Hannegan trail.

Throughout the reserve one need but travel a few miles to find burnt land, as the accompanying map (Pl. LXXIV) will but partially show, many areas being too small to appear. These fires are probably most extensive in August, but the origin of the great fires is often early in the season, from camp and other fires burning in favorable spots until large areas become dry.

Camp fires, slashings, and locomotives have been almost the only sources of fires in this region. The most extensive burning followed the rush of gold seekers to Ruby Creek, some seventeen years ago. Next in importance is the burn along Skagit River from the slashings of settlers. That along the Everett and Monte Cristo Railway, on the headwaters of Sauk and Stilaguamish rivers, is scarcely less; and in every valley dead and tangled timber and gullied mountain sides replace once green and productive slopes.

CAUSES OF FIRES.

Every person entering the woods increases the liability to fire. If unaccustomed to the woods it is increased in greater proportion, especially if, to his unfamiliarity with the conditions under which fire spreads, be added carelessness and the excitement of a prospector's stampede. Fortunately for the Nooksak region, the stampede of 1897 occurred when fires could not spread rapidly, but the 25 camp fires carelessly set along the main trail on the North Fork alone indicate what would have happened if the season had been dry. An impression that prospectors and miners are careless about fires would, however, be erroneous. As a rule they are intelligent and very careful, but the mining tramps, the "snap" hunters, the sharks that follow the true prospector and miner, form a troublesome element, to whom coercion must perhaps be applied if the woods are to be protected from fire. Such people are often unconscious of the damage they do by starting fires. Vigorous and thorough patrolling would be necessary to caution the careless and enforce proper regulations. A good system of fire prevention would have the most hearty cooperation of all good citizens, whether prospectors, miners, lumbermen, ranchers, or merchants. Steam locomotives continue to be a continuous source of fires, notwithstanding the annunciation of railroad men that they use spark arresters and that fires can not be set by their engines. Liability to fire from locomotives might be reduced by the substitution, wherever practicable, of electric motors, for which the mountain streams could furnish power.

The clearing of land is an operation in which it would be most difficult to avoid or prevent the misuse of fires. Grass is scarce both within the reserve and adjoining it, but grows readily when seeded on freshly burnt land, and to the rancher the common temptation to gain a little himself, regardless of great expense to others, also presents itself. Stump lands are especially tempting, for the débris left in logging requires no effort but the lighting of a match to remove it, and the match is usually applied secretly.

EFFECTS OF FIRES.

The once burned areas vary as to new growth from land well stocked with young and thrifty trees of red fir and white pine to barren rock and crumbling shale. Much depends on the time of year the burn occurs. The burnt areas are usually occupied by the plants whose seed first fall upon it. When about half of a stock of mature and seeding trees is killed by fire during August in an abundant seed year, the seeds of the remaining trees are dropped directly into favorable soil conditions for a dense new stock of the same species; but where all the seeding trees on large areas are killed, the reseeding must be with seeds from a distance, carried by wind or animals. The spores of ferns and the downy seeds of fireweed and willow carry well on the wind, and the berries—huckleberry, currant, and raspberry—are carried by animals.

The wide areas severely or repeatedly burned, therefore, have little but weeds and brush growing on them, for the seeds of the best timber trees do not carry so far. Most of the Sultan Valley, small areas of the South Fork of the Stilaguamish and the South Fork of the Sauk, larger areas on the North Fork of the Sauk, and still more on the low, gravelly divide between the Sauk and the North Fork of the Stilaguamish, and small areas on the Suiattle and parts of the Upper Skagit, and on the Nooksak, are found well restocked with timber trees.

In moving down the Sauk River the increasing extent and frequency of fires and their effect were very apparent. About Darrington large

FLOOD IN SKAGIT VALLEY, 1897.

gravelly areas are reduced to scattered groups and individuals of live trees and a scant growth of ferns, huckleberries, and salal.

In passing up the Skagit River above the Sauk very little other than severely burnt land was seen. All the mountain side north of the river is reduced to a nearly barren slope of rock. A few trees are left here and there, but these are in rocky places where fire could not well reach them. Growing on these slopes are some ferns, currant and berry bushes, some vine maple, alder, and willow brush, but very nearly all the land north of the river that is visible from the road is nonproductive, and, with the exception of the narrow strip of agricultural land along the river, promises to remain so indefinitely.

The market value of the timber destroyed by fire in this region is very small. A much greater damage is the prevention of a growth that would some day be valuable—the prevention of the accumulation of a timber resource for the future—and more immediately the exposure to slides and torrents. In some of the basins or narrow valleys the damage from slides may never be very great, owing to the conformation of the slopes. For example, north of the Skagit River, between Sauk City and Marblemount, the mountain side has few long, even slopes where the slide could acquire great force, for the strata of rock, dipping into the mountain, crop out in irregular shelves, which hold the snow and earth and cause the streams to take a zigzag course. Slides are said to be infrequent. This immunity from slides is partially due, without doubt, to the slighter snowfall in this lower altitude and milder climate. In the higher altitudes, however, snow slides are frequent, endangering lives and obstructing travel, destroying mining plants, and rendering any work in their path hazardous. They occur even in the most wooded regions and on the mountain sides, which are often streaked with the light green vegetation that grows in the tracks of the slides. Woods form a great protection against slides, but occasionally tracks are made through a vigorous forest, and when such a barrier becomes weakened or killed by fire, strips of blackened trees pushed down by the snow, and the gray fan-shaped deposits of bowlders, loosened by the destruction of the trees and brought down by torrents, become a common feature of the landscape.

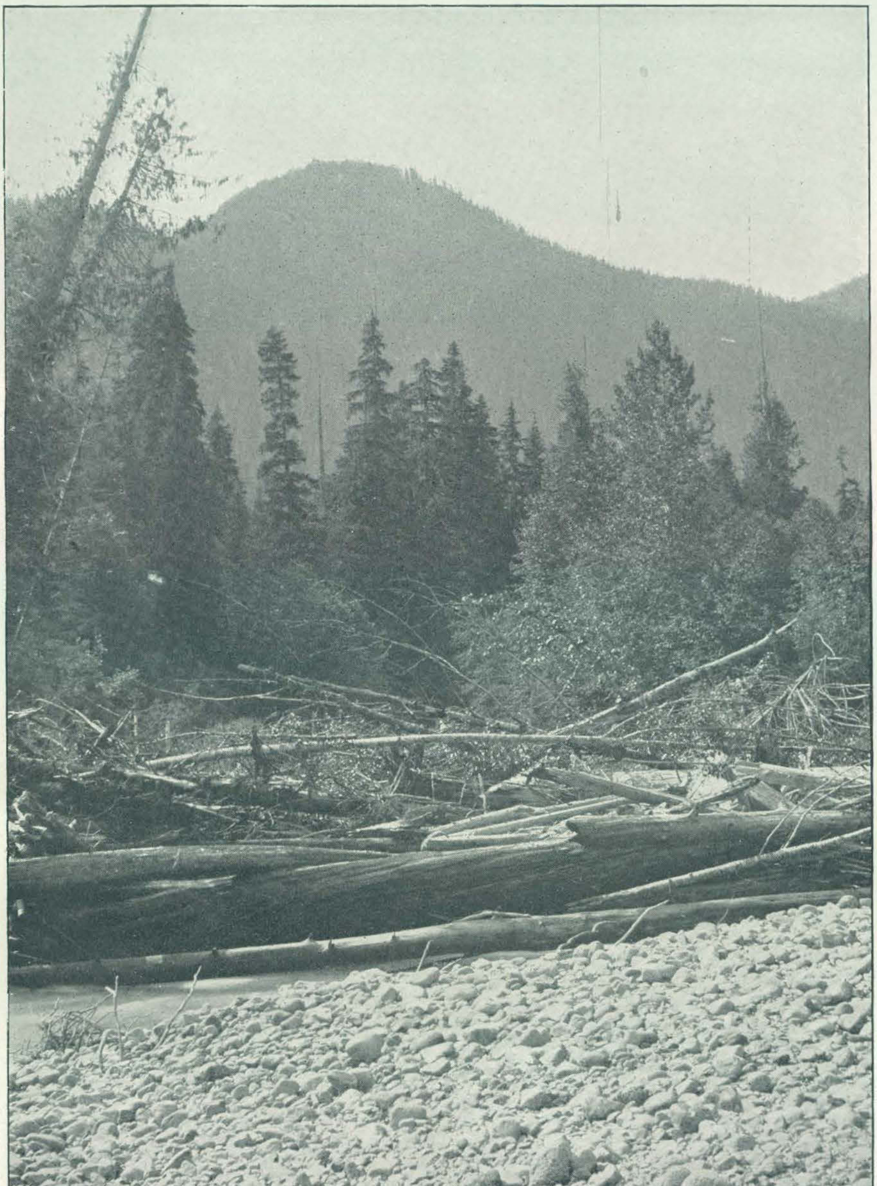
EFFECT OF FIRES ON FLOODS.

In November, 1896, the Sauk River rose to an alarming height, tearing out bridges, roads, and houses, and bringing down great numbers of uprooted trees and other driftwood, even moving large quantities of bowlders, some of them of great size. In November, 1897, a still greater flood came—greater than any known in the tradition of the Indians—flooding farms, drowning cattle, washing out roads and railroads, and endangering lives. The losses approximated $10,000,000.

Reaching Granite Falls November 13, and knowing floods were probable, general notes were taken of the conditions that might cause them. During the previous month rains had been falling frequently in the lower country, while snow fell on the mountains. Three feet of new snow lay on Hannegan Pass October 27, and some 14 inches on the divide between Pilchuck and Sultan rivers on November 16. Where Pilchuck River crosses the west line of the reserve there were the same day 3 inches of snow. Heavy, warm rains began the night of the 16th and continued until noon of the 18th. At 10.00 a. m. on the 17th the Pilchuck was nearly bank full, and on the 18th, at noon, was considered unusually high. But before this the Stilaguamish had rendered the Everett and Monte Cristo Railway impassable, with water 30 feet above its usual height in the canyon, running in fierce torrents through the tunnels and over the tracks. Punctuating the roar of the water, the boom of large bowlders being rolled down the bed of the river could be heard and felt, while the angry, leaping torrent demonstrated its power to the eye by tearing out stone-filled cribbing, bending steel rails, and tossing heavy logs, even whole trees, in its muddy course. But the destruction caused was not very great. The Pilchuck does not head at a very high altitude and has no extensive burns about its headwaters.

The Stilaguamish heads in somewhat higher mountains and has a recently burnt forest (burned in 1894) of about 15 square miles. To attribute the whole flood on the Stilaguamish to the burning of these 15 square miles of its forest would be erroneous, but, whether mere coincidence or cause and effect, the floods since the fire have been greater than those known before. It seems reasonable that fires should have such effect, for at moderate temperatures in higher altitudes it was found that on the wooded areas more of the snow was melted as it fell than in the openings. The covering of trees seemed to keep the earth under them warmer. At Hannegan Pass October 27, while 3 feet of snow lay on the open land, there was seldom more than a foot in the woods close by, and some spots under the trees were entirely bare. The water from this melted snow had filtered away gradually. The accumulated snow in the opening awaited a warm rain, or "chinook," which would melt it rapidly, and then the waters from both the rain and the snow would run off at the same time. At lower temperatures snow ceases to melt as it falls in the woods, and in spring the shading woods greatly retard the melting of snow. In the unburnt woods, too, the moss and litter is usually a foot deep and forms a great absorbent, acting as a sponge or reservoir and regulating the flow of the water. Fires destroy this sponge, as well as the trees, and the water from rain falling or snow melting on the bare surface has nothing to retard it.

Mr. Sutter, of Sauk, who came to the Skagit Valley in 1879, says a period of bank washing along the Skagit followed the forest fires on Ruby, Canyon, and Slate creeks and other tributaries during the gold excitement of seventeen years ago. He says the river is much wider and the volume of the stream is much more changeable than when he



DRIFTWOOD AFTER A FRESHET ON BRANCH OF NOOKSACK RIVER, WHICH DRAINS A PARTLY BURNT AREA.

first knew it. On this question Mr. Jacob Rothenbuhler, a native of Switzerland, living on sec. 2, T. 36 N., R. 5 E., whose well-managed property witnesses his practical wisdom, says:

More of the higher land draining into the South Fork of the Nooksak River, on which I live, should be reserved and protected from fire. When the mountains about the headwaters of streams are bare the sun and hot winds of spring melt the snow so quickly that we who live on the banks of the streams would suffer if fire should destroy the woods and burn off the moss where the water begins to collect. On the lower slopes it does not matter much, but before the water forms into streams it should be retarded as much as possible by trees shading the snow and by the deep mosses that grow in the unburned woods, which, receiving the water as it falls in rain or melts from snow, yield it slowly and steadily to the streams. I have seen streams from bare mountains rise 10 feet in an hour, and our stream here will do the same if the forests about its sources are destroyed. In Switzerland much care is taken to keep the higher slopes wooded as a protection against snow slides and floods.

PRECAUTIONS AGAINST FIRES.

In Snohomish County much care is taken to prevent fires. The county commissioners and the 45 Consolidated Mining Company post placards prescribing severe penalties for those who start fires.

The 45 Consolidated Mining Company, Mr. W. F. Brown, general manager, employs no one who smokes. Mr. Sutton, superintendent of the Monte Cristo concentrator and mines, says great care is taken by him to avoid fires. The miners and prospectors in the vicinity of Silverton say they are very anxious to avoid fire and to keep the timber that is on their claims. In the northern portion of the county less care is taken. The settlers start fires rather freely, to enlarge their clearings. In Skagit County great carelessness exists, as shown not only by the large areas burned over in the past, but even more by the number of unextinguished and spreading fires found burning there.

Whatcom County now has men interested in mining properties who take much interest in the development of their region, and who may be relied on to aid every reasonable effort to prevent the spread of fires. This county is likely to be visited by many prospectors during the next year, and more than usual precaution will be necessary to prevent extensive fires if the season is dry.

DEMAND FOR TIMBER.

But little timber is needed by prospectors. A cabin, fuel, and a few props or a little cribbing suffice until mining begins, when the demands increase with the work.

It is an interesting fact that at Monte Cristo and Silverton, although surrounded by forests, lumber and fuel are brought by railroad from below Granite Falls, the red fir (*Pseudotsuga taxifolia*) being considered much better for both purposes than the amabilis fir (*Abies amabilis*) or the hemlock (*Tsuga mertensiana*), which grow abundantly in the vicinity.

On the other hand, some properties are so situated that local timber must be used. The 45 mine, for example, is several thousand feet above the railroad and beyond the divide. Supplies have been packed in and ore has been packed out. In the future an aerial tramway will be used. A sawmill has been erected to cut the limited supply of mountain cedar (*Chamæcyparis nootkatensis*), and with it hemlock (both *Tsuga mertensiana* and *T. pattonii*) and amabilis fir (*Abies amabilis*), the mountain cedar being used for the most trying conditions.

Prospectors could do their work by using dead timber or inferior growth, leaving standard stock unharmed, or even improved, by judicious cutting. Practically, however, without supervision, any restraint on cutting by prospectors would merely be a handicap on those who respect the law. Mining operations being more permanent, the cutting of timber and fuel for mines could probably be placed under such regulations that when certain timber was needed an inspector could indicate from what trees it might be taken.

At present the local demand for timber within the reserve is very small. Two small sawmills have been operated, one at Monte Cristo, the other at the 45 mine, near Silverton. But a few thousand feet of lumber has been or can be sawed by either. No logs have been driven down the stream from the reserve. Timber has been cut and driven down Sauk River from near the reserve line, and down Skagit River from the mouth of Bacon Creek, but none from within the lines. The logging operations nearest the reserve at present are on the North Fork of the Stilaguamish, some 3 miles west of the reserve line.

TRANSPORTATION.

Large operations might be carried on with some profit, even by driving logs in the streams, but none of the streams within the reserve may be considered good for floating logs. Numerous obstructions, both shifting and fixed, and frequent and sudden changes in the stage of water make the driving of logs, and even of cedar bolts, very difficult and subject to losses.

Logs or lumber could probably be transported more satisfactorily either by flumes or by electric railway. Much can be said in favor of the latter in this region. An electric railway could utilize the abundant water power in the reserve; freedom from sparks would give it an advantage over the steam railroad; and with transportation for supplies and equipment, mining and other industries would be greatly stimulated within the reserve. With such lines in operation, and the reserve under systematic and permanent management, forest products could be manufactured nearer the stump, and the waste material need not be hauled so far. Good transportation is vitally essential to the best use of the reserve. With it a great proportion of the tree growth can some day be utilized, if protected from fire and kept growing, and mines now idle can be worked. Without it the greater portion of the region must remain nonproductive.

MONTE CRISTO, AND BURNT AREAS NEAR IT.

MINERALS.

At Monte Cristo the mining, concentrating, and shipping of base ores of gold, silver, lead, and copper have several years supported a population of nearly 1,000 people. At Silverton, with about the same population, promising mining properties are being developed. At Goat Lake extensive developments are under way. All these operations, however, must be seriously affected by the recent destruction of the Everett and Monte Cristo Railway. Promising developments are being made in the White Horse district, near Darrington, along the main divide at the head of Cascade River, and northward about the heads of Thunder Creek. In fact, everywhere throughout the mountains claim stakes are abundant, and prospectors are frequently met on the main trails going into the mountains to do their annual assessment work.

On Ruby Creek and its tributaries free gold is found, with some difficulty, in considerable quantities, and it can hardly be doubted that thorough study and persistent work will make these placers pay. Sluicing during 1897 was remunerative to some of the operators. It is hoped that when the test pit on the "Nip and Tuck" reaches bed rock the resources of the old channel, frequently filled and covered by slides, may be known.

A stamp mill has been erected during the season on Slate Creek, to work the quartz of the Eureka, Mammoth, and other mines of the vicinity. Placer gold was seen also on a tributary of Baker River south of Mount Shuiksan. North of Mount Baker and Mount Shuiksan the rugged range from Hannegan Pass to Tommahi Mountain and beyond, in British Columbia, is beset with claim stakes, placed there during the Nooksak stampede of the late summer and autumn.

EASTERN PART OF WASHINGTON FOREST RESERVE.

By Martin W. Gorman.

ITINERARY.

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

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

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

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

TOPOGRAPHY.

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

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

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

A. VIEW UP RAILROAD CREEK.

B. BURN IN STEHEKIN VALLEY.

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

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

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

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

One of the most noticeable features of the whole region is the large number of ancient water levels, or, as they are locally called, "benches." The best marked of all these is probably the one known as the "1,800-foot level," which is in reality 1,839 feet above sea level, or 731 feet above the present level of Lake Chelan. This bench can be traced down to and along the Columbia River, and up the Methow River until it reaches the corresponding level in that stream at the present time, and it is easily traceable on Squaw Creek and numerous other small streams. When the water stood at that level the waters of Lake Chelan, the Columbia, the Methow, and some of the tributary streams of the latter were united in a large lake, while the present Antoine Coulée formed a narrow strait between Chelan and the Methow, the summit of its present eastern wall forming a narrow, rocky island. Later on, when the Columbia, farther down its course, had deepened its bed by erosion, and so lowered the level of this ancient lake, the Chelan watershed for a time found an outlet through the present Knapp Coulée, thus forming the next prominent bench, at 1,561 feet. At a still more recent period the Chelan River, $3\frac{1}{2}$ miles long, came into existence, and, as it lowered the lake level by alternate periods of rapid erosion and temporary stationary halts, numerous benches between that of 1,561 feet and the present lake level were formed, none of them, however, so well defined as the two just mentioned. A similar series of benches may be seen along the Methow, caused by alternate eroding and stationary periods on that stream and the Columbia. That this process is still going on in the Chelan Basin can scarcely be questioned, but owing to reduced precipitation in the region, with consequent reduction in volume of water of the annual spring freshets, it is much slower and less noticeable, but I think none the less certain, than formerly.

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

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

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

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

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

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

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

CLIMATE.

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

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

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

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

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

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

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

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

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

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

SOIL.

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

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

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

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

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

AGRICULTURE.

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

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

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

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

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

GRAZING.

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

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

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

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

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

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

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

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

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

DRAINAGE SYSTEM.

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

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

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

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

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

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

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

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

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

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

UTILIZATION OF THE WATER SUPPLY.

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

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

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

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

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

VEGETATION.

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

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

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

YELLOW-PINE ZONE.

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

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

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

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

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

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

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

The dominant shrubs and undershrubs may be enumerated as follows:

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

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

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

THE LODGEPOLE-PINE ZONE.

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

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

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

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

Linnæa borealis.
Anaphalis margaritacea.
Hieracium albiflorum.
Castilleja linariæfolia.
Achillea millefolium.
Hieracium cynoglossoides.

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

THE SUBALPINE-FIR ZONE.

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

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

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

The most noticeable shrubs and undershrubs in this zone are:

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

The dominant plants found here are:

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

THE WHITE-BARK-PINE ZONE.

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

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

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

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

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

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

Pachystima myrsinites.
Bryanthus empetriformis.
Cassiope mertensiana.
Azalea albiflórum.
Ledum glandulosum.
Sambucus racemosus?.
Artemisia ludoviciana.

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

The principal plants of this zone are:

Eriogonum umbellatum.
Oreobroma columbiana.
Arenaria capillaris.
Sedum stenopetalum.
S. divergens.
Saxifraga tolmæi.
Polemonium pulchellum.
Pentstemon menziesii.
P. scouleri.
P. proceus.
Macronema suffruticosum.
Erigeron sp. (No. 589).

MOIST VALLEYS AND CANYONS.

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

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

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

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

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

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

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

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

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

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

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

Acer circinatum was seen only on the Stehekin.

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

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

The characteristic plants of these valleys are:

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

TREES OF THE REGION.

PINUS MONTICOLA Dougl. (Mountain white pine.)

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

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

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

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

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

PINUS ALBICAULIS Engelm. (White-bark pine.)

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

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

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

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

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

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

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

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

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

PINUS MURRAYANA Balf. (Lodgepole pine.)

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

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

LARIX OCCIDENTALIS Nutt. (Western larch.)

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

PICEA ENGELMANNI Engelm. (Engelmann spruce.)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

It ranges in height here from 70 to 120 feet and in diameter from 20 to 50 inches. It grows very rapidly for the first one hundred and fifty years, but after that period gradually becomes of slower growth. The bark is very thick, exceeding even that of the yellow pine, and on this account the grown tree is enabled to withstand a forest fire in which the lodgepole pine, Engelmann spruce, or any of the firs would perish. Among the specimens measured, a tree at 5,510 feet elevation, 132 years old, gave a diameter at stump height of 18¾ inches inside and 21¾ outside bark, while one at 1,200 feet elevation, 244 years old, was 43 inches in diameter inside and 49 inches outside bark. About 10 per cent of the lumber used here is supplied by this tree, and its wood excels that of all others in this region for fuel. For some reason the tree is not so healthy here as west of the Cascade Range, fully 50 per cent of the grown trees being found to be affected with fasciation. About lake level it is rather stunted in growth and much twisted and gnarled by the winds, so that the benches and higher levels must be sought for trees suitable for lumber.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

JUNIPERUS NANA Willd. (Creeping juniper.)

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

TAXUS BREVIFOLIA Nutt. (Pacific yew.)

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

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

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

SALIX FLUVIATILIS Nutt. (Longleaf willow.)

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

POPULUS TREMULOIDES Michx. (Aspen poplar.)

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

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

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

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

ALNUS OREGONA Nutt. (Red alder; Piskwaus name, Kuh-skwē'alp.)

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

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

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

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

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

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

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

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

CRATÆGUS DOUGLASII Lindl. (Western haw.)

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

CRATÆGUS SP. (No. 803.)

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

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

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

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

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

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

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

ACER CIRCINATUM Pursh. (Vine maple.)

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

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

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

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

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

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

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

SAMBUCUS CALLICARPA Greene. (Redberry elder.)

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

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

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

FOREST FIRES.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

FOREST PRESERVATION.

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

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

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

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

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

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

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

SAN JACINTO FOREST RESERVE.

(PRELIMINARY REPORT.)

By JOHN B. LEIBERG.

AREA, TOPOGRAPHY, AND CLIMATE.

The San Jacinto Forest Reserve comprises about 740,000 acres. It consists of (1) the main San Jacinto Range, extending from San Gorgonio Pass in a southeasterly direction to the head of Bull Creek, with its eastern and western slopes, including the various secondary divides that separate the numerous canyons; (2) Toro or Bull Mountain Range, properly a continuation of the San Jacinto Range from Bull Creek south, but with a more easterly trend, its southeastern extremity ending in the Colorado Desert, but connecting by a mesa and low divide at the head of Coyote Creek with the timbered ridges known as Smiths Range, south of Temecula Canyon; (3) The mesa region, two plateaus of considerable extent; one, the Toro or Piñon Flat Mesa, comprising the area bounded on the south and west by Toro Mountain, on the north by Bull Creek, and on the east by the Colorado Desert; the second, known as the Cohuilla Mesa, comprising the region west of the headwaters of the South Fork of the San Jacinto and of Coyote Creek, and which forms in part the drainage basins of Cohuilla and Temecula creeks.

The region varies in elevation from 3,000 feet above sea level for the mesa portions to 7,000 to 10,000 feet for the main San Jacinto Range, the northern portion attaining the greatest elevation and having for its culminating point San Jacinto Peak. The main range is flanked on the western slope by several plateau-like basins which serve as the heads or reservoirs of the larger branches of the San Jacinto River. Some of these basins, as that of the South Fork of the San Jacinto, form extensive flats; others are small and more or less broken by low intersecting ridges. The drainage from the western slope flows into the San Jacinto plains. The eastern declivity of the range descends very steeply to the Colorado Desert and is much cut by deep, rocky, and narrow canyons. Its drainage flows into the desert. The northern end of the range is rocky and precipitous and rises sharply from the plains that form the San Gorgonio Pass. The Toro Range is a steep and rocky elevation, sending its entire drainage into the Colorado Desert.

The mesa areas are undulating tracts more or less intersected by canyons and low, irregular, disconnected rocky or bowlder-strewn ranges of hills. The Toro Mesa has but little level land, the canyons from the Toro Range and Bull Creek cutting into it in all directions. The Cohuilla Mesa is comparatively level in much of its eastern and central portions. The edges of the mesas, where they break off to the plains or desert below, are cut and gashed by great bowlder-strewn canyons, usually with sharp and rapid descents.

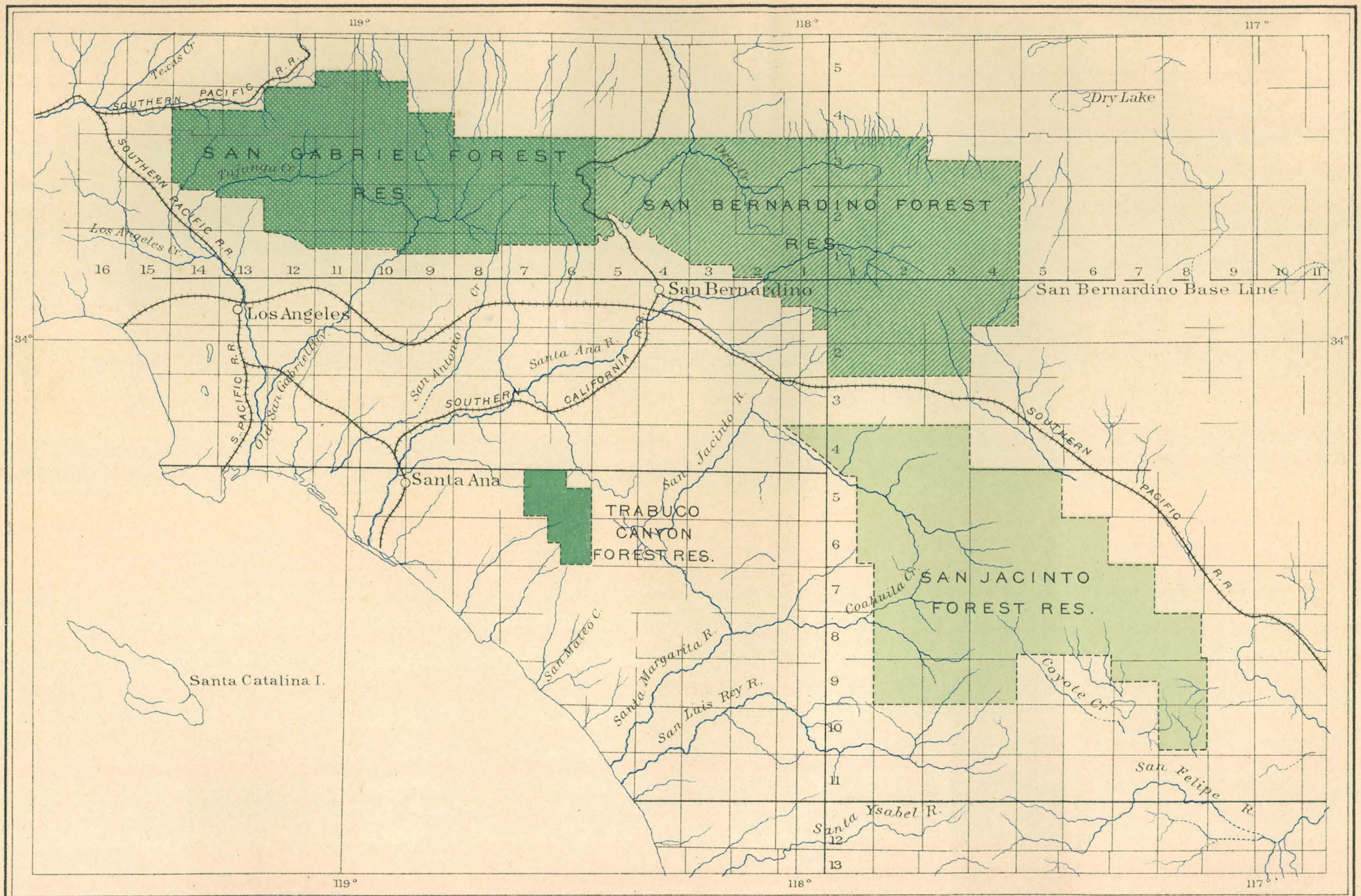
The rock formation is mainly granitic, except along the desert and on the Toro Mesa and ranges, where schistose rocks occur extensively, interrupted by volcanic dikes. The southern portion of the San Jacinto Range, Toro Mountain, and the areas contained in the Toro Mesa are gold bearing. Many claims are located on Toro Mountain, and considerable development work has been done. A stamp mill is, or soon will be, in operation near Kenworthy, on the South Fork of the San Jacinto.

The soil is chiefly a more or less finely comminuted granitic detritus, mixed near the surface with a small percentage of black mold. Humus, that is, the decaying layer of vegetable débris common in the forests of Idaho, Washington, and Oregon, is lacking everywhere on mountain slope and mesa. Considerable tracts of the steeper mountain sides, especially near San Jacinto Peak, are bare, craggy rocks, while other areas near the desert and on the breaks of the mesas are bowlder-strewn or sandy and gravelly wastes. On the Cohuilla Mesa occur tracts with the top soil of gray or black mud, often white, with an alkaline efflorescence. Similar soil is found here and there in the basin or upper portion of the South Fork of the San Jacinto.

The climatic conditions of the reserve are those of a semiarid region at elevations below 4,800 feet above sea level. The eastern slopes are more arid than the western; the southern more than the northern. Along the eastern boundary of the reserve and over the two townships in the extreme southeastern corner, true desert conditions prevail. Above elevations of 4,800 feet the precipitation increases rapidly, but there are no records showing its yearly amount. The character of the forest growth indicates about 20 or 25 inches as the total quantity for elevations between 4,800 and 5,500 feet, and about 30 or 35 inches for elevations between 5,500 and 8,000 feet, on the western slopes. At higher altitudes the timber and brush furnish no further indications, as temperature conditions become more prominent features in the forest growth than the annual precipitation. It is said that snow to the depth of 15 feet falls on the high summits around San Jacinto Peak. The northern slopes of this peak carry snow throughout the year at elevations above 9,500 feet. The precipitation on the eastern slopes is much less than on the western.

VEGETATION.

The native vegetation on the reserve presents three chief aspects: (1) a forest growth of deciduous-leaved and coniferous or evergreen trees other than coniferous, more or less compact, more frequently



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SOUTHERN CALIFORNIA

SHOWING LIMITS OF FOREST RESERVES

SCALE

0 10 20 30 40 50 MILES

open and comparatively free from large undergrowth; (2) a brush growth of many species of shrubs, some deciduous leaved, but the majority evergreens, extremely dense in most places, often truly impenetrable without the use of the ax, sometimes with scattered trees rising in the midst of the sea of shrubs, but commonly composed exclusively of frutescent species; and (3) grassy expanses, usually small in extent.

Each of these aspects occurs under various forms. The timbered areas beginning at the level of the valleys on the western slopes are merely thin lines of deciduous-leaved trees or evergreen oaks below the 3,500-foot contour and are mostly confined to the banks of the water courses. On the eastern slopes scattered trees of the single-leaved nut pine occur on the hillsides. Between the 3,500- and 4,800-foot contours the timber growth on the western slopes receives an addition in the big-cone fir and the big-cone pine, which are found, often in considerable quantities, bordering the streams, scattered over the moist northern slopes of the hills, or forming compact groves in the upper and sheltered portions of the canyons. The trees below the 4,800-foot contour on the western slope are principally evergreen oaks, willows, sycamore, walnut, alder, and cottonwoods, in addition to the two species of conifers already mentioned, and occasional trees of the yellow pine, which sometimes descends as low as the 4,000-foot contour. On the eastern slope the single-leaved nut pine occurs in the greatest abundance between the 3,500- and 4,800-foot contours. Above the 4,800-foot contour the forest growth becomes heavier and is composed chiefly of coniferous trees.

The brush areas, commonly called "chaparral," cover many thousands of acres of the reserve below the 5,000-foot contour. The growth, which is commonly very dense, consists chiefly of scrub oaks, "grease wood," and "buck brush." On the eastern slope great tracts are covered with an almost pure growth of the arborescent chrysothamnus. The chaparral varies from 5 to 12 feet in height. Occasionally a tract occurs covered with the common sagebrush (*Artemisia tridentata*), especially on the alkaline areas of the Cohuilla Mesa. Above the 5,000-foot level the chaparral diminishes in density of growth. At 5,700 feet and above it occurs in interrupted patches throughout the forest growth, and in solid masses, but of low stature, on the southern portion of the San Jacinto and Toro ranges to elevations of 8,000 feet. The ultimate altitudinal range of the chaparral belt is about 10,500 feet, and is at high elevations almost wholly composed of species of manzanita, buck brush (ceanothi), and the shrubby chinquapin.

The meadow lands are circumscribed in area and are situated mostly in the basin of the upper South Fork of the San Jacinto and on the Cohuilla Mesa. They are covered with grass or rush (*Juncus balticus*), or, where they have been closely pastured in the past, a thin growth of alfilaria (*Erodium circutarium*) has taken the place of the grass or rush.

Fires have run through the coniferous forest everywhere except, perhaps, in isolated localities around San Jacinto Peak. The piñon flats on the Toro Mesa have also escaped. The damage from fire to the growing forest has not been extensive; I should place it at less than 4 per cent. The greatest damage in the timber belt has been done to the firs, Murray pine, and incense cedar. The chaparral has suffered more. It is almost certain that the entire brush-covered area of the reserve has been repeatedly destroyed by fire in the past. Recent fires—that is to say, within the last eight or ten years—have burned over about 14,000 or 15,000 acres scattered throughout the reserve in small tracts. Fires in the open timber do comparatively little damage. There is not enough litter on the ground to sustain a hot, lasting fire, and the species of trees valuable for commercial purposes, the yellow and sugar pines, possess a large fire-resisting power. Fires in the chaparral destroy the brush growth only temporarily; the roots are rarely killed, and as the species are all perennials, a new growth soon springs up; but scattered coniferous trees or groves among the chaparral are almost invariably killed. Brush fires are difficult to control or subdue. Fires in the forest can be extinguished with but little trouble, owing to the absence of humus or litter. Reproduction of the forest is generally rapid and abundant between the elevations of 4,800 and 8,000 feet, whether the original growth has been destroyed by fire or by the ax. Above and below these limits it is quite slow. After a fire the same species that originally grew on the tract come in again in about the same proportions. There is not the slightest evidence to prove that the chaparral areas were ever covered with timber within the historic period, nor that fires increase these areas at the expense of the timbered regions.[1]

The agencies that regulate the run-off from the reserve are, primarily, the amount of fissuring of the underlying bed rock, and, secondarily, the chaparral on the hillsides. The coniferous forest growth does not influence this matter in the least degree. The chaparral holds the loose soil or gravel in place on the steep hillsides, causing it to perform the office of a water sponge.

An unknown number of cattle and horses—probably 1,500 or 2,000 head—graze within the reserve. They are scattered over the whole reserve, but there are more on the Cohuilla Mesa and in the basins of the South Fork of the San Jacinto and Bull Creek than elsewhere. There are no sheep at large within the reserve.

Timber cutting has been extensive in the upper basins of the North Fork and the Middle Fork of the San Jacinto. The beginning dates back between fifteen and twenty years. There are at present three sawmills in the region; two are in operation. Most of the timber lands that are accessible have been surveyed and the title is vested either in

[1] The limits of the chaparral in the San Jacinto and San Bernardino reserves are determined by climatic conditions, rainfall, and temperature-altitude; not by fires.

A. VIEW IN STRAWBERRY VALLEY, SAN JACINTO FOREST RESERVE, CALIFORNIA, SHOWING OAKS AND YELLOW PINES.

B. YELLOW-PINE AND SUGAR-PINE TIMBER, SAN JACINTO FOREST RESERVE, NORTH FORK SAN JACINTO RIVER.

the Southern Pacific Company or in private individuals. The chaparral on the Cohuilla Mesa and adjoining area is being converted into firewood.

The agricultural lands within the reserve are situated in the upper portion of the South Fork of the San Jacinto, on the Cohuilla Mesa, and its extension at the head of Coyote Creek, and amount to about 35,000 acres. In addition to this there are a few flats of 10 to 50 acres along some of the smaller streams that are suitable for agricultural operations. In these estimates are included such lands below the 5,300-foot contour as are sufficiently level and free from bowlders to permit of cultivation. At present the areas are mostly covered with chaparral. In actual practice not more than about one-seventh of the above amount could be utilized, owing to the utter lack of the necessary water for irrigation.

The areas carrying bodies of timber valuable for other purposes than firewood are situated as follows: In the upper basin of the North Fork of the San Jacinto; in the upper basin of the Middle Fork of the San Jacinto (Strawberry Valley); on the summit and upper slopes of the northern portion of Wild Hog Ridge, the divide that separates the South Fork of the San Jacinto from the Cohuilla Mesa; in the basin of the South Fork of the San Jacinto, and on the western half of the upper slopes of Toro Mountain—in all about 32,560 acres. The areas carrying timber valuable principally for firewood are scattered throughout the reserve, the largest solid body of this kind being the piñon flats on Toro Mesa and Mountain.

TABLES.

TIMBERED AREAS.

The following figures are subject to revision when a closer compilation shall have been made of the maps and sketches covering the different tracts embraced in the reserve:

Estimates of the various areas in the San Jacinto Reserve.

		Acres.
Approximate area in the San Jacinto Forest Reserve		737,000
Timbered areas	141,000	
Brush-covered areas	530,000	
Desert and naked rocks	57,520	
Meadow or alkaline flats	6,000	
Cultivated tracts	2,000	
Streams, etc	480	
Total		737,000

The area of cultivation would be largely increased if the northern boundary of the reserve covers any of the cultivated lands in San Gorgonio Pass.

Composition of the forested areas.

		Acres.
Class I.	Commercial timber areas accessible and carrying more than 1,000 feet merchantable timber per acre	32,560
Class II.	Commercial or noncommercial timber areas hardly accessible, or so only with difficulty, carrying less than 1,000 feet per acre, piñon forest excluded	58,960
Class III.	Piñon forest and flats	50,000
	Total	141,520

AMOUNT OF TIMBER.

Amount of merchantable timber other than firewood.

	Feet.
On the timber areas of Class I, fair to prime in quality	87,110,000
On the timber areas of Class II, poor in quality	11,000,000
On the timber areas of Class III	0
Total	98,110,000

These estimates are based on the customary method of scaling standing timber. The sawmills in the reserve, however, handle the timber in the most economical manner possible, utilizing the trees far up in the crown, where the diameter of the trunk dwindles to 8 inches or less. Worked up in this manner, the quantity of available merchantable timber would amount to at least 200,000,000 feet, and by sawing the best trees of the firs (*Abies concolor* and *Pseudotsuga macrocarpa*), now rejected for no very good reasons, there would be added to the above amount about 15,000,000 feet.

Principal distribution of the commercial timber of Class I by areas

Area.	Acres.	Feet.
North slopes of San Jacinto Range	3,840	13,590,000
Basin of North Fork of San Jacinto River	8,220	33,600,000
Basin of Middle Fork of San Jacinto River	7,400	20,880,000
Wild Hog Ridge and upper South Fork of San Jacinto River.	3,200	8,400,000
Toro Mountain *a*	8,000	20,640,000

a Including south slopes, now perhaps outside the reserve, partly covered by the St. Rosa Indian Reserve.

TIMBER TREES.

Composition of forest exclusive of piñon pines, junipers, and deciduous-leaved trees other than oak.

3,000 TO 6,000 FEET CONTOUR.	Approx. per cent.
Pinus ponderosa	80
P. lambertiana	2
P. coulteri	6
Libocedrus decurrens	3
Pseudotsuga macrocarpa	3
Oaks	5

A. YELLOW-PINE AND SUGAR-PINE TIMBER, SAN JACINTO RESERVE.

North Fork of San Jacinto River, 7,000 feet above sea level.

B. SLOPES ON NORTHERN SIDE OF GRAYBACK RANGE, SAN BERNARDINO RESERVE, BEARING *Pinus murrayana* AND *Pinus flexilis*.

Summit of ridge three-fourths of a mile west from Grayback Peak; altitude 11,000 feet.

6,000 TO 8,500 FEET CONTOUR.	Approx. per cent.
Abies concolor	30
Pinus lambertiana	25
P. ponderosa	30
Libocedrus decurrens	6
Pinus murrayana	5
P. coulteri	1
Oaks	2

Composition of piñon forest.

Pinus monophylla	99
Yucca, oak, ash, cottonwood, and willows	1

Junipers are excluded, as they are scarcely more than shrubs here.

Coniferous trees utilized for lumber.	Per cent.
Pinus ponderosa	95
P. lambertiana	4
Libocedrus decurrens	1

The sugar pine is not used so extensively as it would be if more easy of access. The incense cedar is used mainly for shakes (hand-split shingles). The white fir is rejected, as is also the big-cone fir (here commonly called hemlock). Both should supply box lumber, a use to which the less desirable portions of the yellow-pine logs are now put.

Description of the principal coniferous trees in the reserve.

Coniferous tree.	Description.
Pinus ponderosa (yellow pine).	2 to 5 feet in diameter; 60 to 150 feet in height; 20 to 50 feet clear trunks; range between 3,000 and 9,000 feet.
P. coulteri (Coulter pine)	10 to 20 inches in diameter; 20 to 50 feet in height; no clear trunks; range between 4,500 and 6,500 feet.
P. lambertiana (sugar pine).	1½ to 4 feet in diameter; 50 to 90 feet in height; 10 to 30 feet clear trunks; range between 5,800 and 9,800 feet.
P. monophylla (single-leaf piñon).	8 to 16 inches in diameter; 15 to 45 feet in height; no clear trunks; range from 5,800 feet down.
P. murrayana (lodgepole pine).	1 to 3 feet in diameter; 20 to 40 feet in height; clear trunks, none to 10 or 15 feet; range between 8,000 and 10,500 feet.
P. flexilis (limber pine)	1 to 2 feet in diameter; 15 to 25 feet in height; clear trunks none, or 10 to 12 feet; range between 9,000 and 10,500 feet.
Libocedrus decurrens (incense cedar).	2 to 4 feet in diameter; 50 to 90 feet in height; usually has no distinctive clear trunks, but sometimes reasonably clear for 10 to 20 feet from the base; range between 3,000 and 8,000 feet.
Pseudotsuga macrocarpa (big-cone fir).	1 to 4 feet in diameter; 40 to 60 feet in height; usually no clear trunks; range between 3,000 and 5,500 feet.
Abies concolor (white fir)	1½ to 3 feet in diameter; 40 to 90 feet in height; clear trunks none, or sometimes 15 to 30 feet in favorable situations; range between 6,000 and 10,000 feet.

SAN BERNARDINO FOREST RESERVE.

(PRELIMINARY REPORT.)

By JOHN B. LEIBERG.

AREA, TOPOGRAPHY, AND CLIMATE.

The San Bernardino Reserve, an area, approximately, of 737,000 acres, consists wholly of the San Bernardino Range of mountains with some outlying but connected parallel ranges on the Mohave side east of Bear Valley and the head of Santa Ana River. The main range of mountains has generally a southeasterly trend and varies in elevation from 5,000 feet at the western extremity to 9,500 feet at the head of the Santa Ana River. It sends out a number of secondary ranges, the most conspicuous being the divide that separates the Mill Creek drainage system from the Santa Ana, and the one between Mill Creek and San Gorgonio Pass. The former rises to elevations of 11,600 feet at Grayback Peak. The summit of the main range is generally narrow and rocky. From Cajon Pass to the head of Plunge Creek the southern and western slope rises steeply from the San Bernardino plain. From Plunge Creek to San Gorgonio Pass the slope becomes longer, amounting to as much as 30 miles along the axis of the Santa Ana Canyon. On the south slope, at San Gorgonio Pass, the range has a broken foothill region 3 or 4 miles wide, beyond which rise sharply the rocky ridges of the Mill Creek divide. On the north and on the eastern side of the range there is a long slope, forming the Deep Creek Basin as far south as the head of Holcomb Valley. Farther south the main range drops abruptly to a system of parallel ranges, fronting on the Mohave Desert, and having collectively a width of 10 or 12 miles. The range is granitic throughout the greater portion. Several of the parallel ranges along the Mohave Desert are formed of schistose rocks, and a wedge of crystalline limestone and quartzite is found at the head and on the north side of Bear Lake. A large area of the reserve in the southeastern portion is gold and copper bearing. Many mining claims are located in various places, and considerable development work has been done in the past. The only property seen that was being worked—apparently on a profitable basis—was the Rose mine, near the borders of the Mohave Desert. There is little doubt that paying mines will be developed in other portions of the reserve. The soil is gravelly or sandy, and generally thin, except in the Bear Valley meadows. The valleys that abut on the reserve on the west and south are arid in character, and those on the north and east are true deserts.

The greater portion of the drainage from the range flows into the San Bernardino plains, but part flows into the Mohave Desert.

The summit of the main range is narrow, very broken, and rocky in some portions. The canyons and streams generally originate in flats, commonly of small extent, but in the case of Bear Valley Basin upward of 7,000 acres are contained in one system of meadows. The canyons from Cajon Pass to Plunge Creek are exceptions; these in several instances take nearly vertical plunges of several thousand feet from their heads. The stream valleys are generally narrow and rocky, frequently for long distances mere gorges. The valley of Santa Ana contains several level expanses, or meadows, in the upper portion, and a few of small extent also occur in the valley of Mill Creek. All the canyons have rapid descents. The stream beds are masses of bowlders of all sizes, which gradually work down and are swept out on the plains, forming the so-called "wash."

Agricultural lands within the reserve consist of the small flats at the heads of the streams, level tracts in the valleys, and small areas of bench lands between the canyons. The altitudinal limit of land of this class may be placed at about 6,000 feet. Agricultural operations are not extensive. Small areas in the Santa Ana and Mill Creek valleys, some tracts along the south end of the range at San Gorgonio Pass, and various patches at the head of City Creek, and farther westward at Strawberry Flats, are under cultivation. Lack of available water is a bar to extensive utilization of the lands within the reserve for agriculture. I estimate that the total of all lands suitable for agriculture, below the 6,000-foot contour, amount to about 25,000 acres; owing, however, to lack of water, only a small portion of these can be utilized. There are practically no agricultural lands on the Mohave side of the range.

There is a large area of grazing land. It lies between the 4,800- and 9,500-foot levels, and consists of the areas covered with yellow pine, margins of creeks and streams, oak openings, and level stretches of meadow land free from timber. The open meadow lands exist chiefly along Little Bear Creek, a tributary of Deep Creek; Bear Valley Creek, the largest affluent of Santa Ana; and the upper portion of the main Santa Ana Valley. The grass growth in the timber is rather scanty, but on the open meadow lands is fair in quantity. A few hundred head of stock are regularly pastured in the reserve. This year, owing to the prevailing drought, several thousand head have been driven to grazing areas.

VEGETATION.

The general vegetative aspect of the reserve is of two kinds, forest and chaparral. The chaparral below the 5,000-foot contour consists principally of buck-brush, "grease wood," and scrub oaks, and is usually of dense growth from Cajon Pass southward to the Santa Ana Valley on the western face of the range; farther southward it becomes more open and of lower stature. On the eastern and northern face of the range, from Cajon Pass to the mouth of Deep Creek, the growth is generally more open, thinning out and nearly disappearing along the borders of the Mohave Desert. South of Deep Creek the chaparral is open and is composed chiefly of yucca, cactus, shrubby juniper, and mountain mahogany. Above the 5,000-foot level the chaparral is composed chiefly of buck-brush and a species of manzanita, and occurs in narrow belts scattered among the forested tracts, or occasionally, as at the head of Bear Lake, in continuous areas covered with the common sage brush (*Artemisia tridentata*). At elevations of 8,500 to 10,000 feet the brush growth is low and scraggy and is composed almost exclusively of species of manzanita and shrubby chinquapin.

The forest growth on the southern and western slopes commences at the plains level, or 1,600-foot contour. At first it merely appears as thin lines, composed of oaks, sycamore, willow, cottonwood, walnut, and alder, bordering the stream margins. At elevations of 3,000 feet, patches of the big-cone fir begin to appear on the northern slopes and in the canyons, increasing in extent with elevation, and forming in some places large groves in the upper portion of the canyons at altitudes of 4,500 to 5,000 feet. The main body of coniferous forest begins at about 5,000 feet elevation. It covers the main ridge and the secondary ranges on the western and southwestern slopes of the uplift between the altitudes of 5,000 and 10,000 feet, from a few miles east of Cajon Pass to the head of Mill Creek and southward from the head of this creek along the summit and slopes of the divide that separates it from San Gorgonio Pass. On the northern and eastern slopes of the range the forest occupies the upper portion of the Deep Creek Basin and follows the main divide to near San Gorgonio Pass. The parallel ranges flanking the main ridge east of Bear Lake and the head of Santa Ana likewise bear a coniferous growth, which, however, rapidly thins out and disappears a few miles away from the main range.

The forest on the western and southern slopes of the main divide and on its flanks and secondary ridges between the 5,000- and 9,500-foot contours is composed chiefly of yellow and sugar pines, incense cedar, and white fir, with occasional oak openings. On the southern side a similar forest prevails to the head of Holcomb Valley, where it receives an admixture of the piñons and junipers, which form the prevailing forest trees on the ranges bordering the Mohave Desert.

Above the 9,500-foot contour the forest growth is much interrupted by patches of naked rocks, and is composed of white fir, lodgepole pine, and limber pine, with occasional trees of sugar pine and yellow pine in the lower edges of the belt. The piñon belt lies to the east of the main range, on the slopes, reaching to the Mohave Desert. It extends from San Gorgonio Pass to the mouth of Deep Creek in a fairly continuous stretch, thinning out near the edges of the desert, and nearly disappears on the areas between Deep Creek and Cajon Pass. The piñon forest is nowhere a pure growth, being largely mixed with juniper, yucca, and mountain mahogany.

The quality of the timber growth for commercial purposes is generally fair as regards the yellow and sugar pine. The lumber produced from the yellow pine is regarded as inferior to the lumber of the same tree growing farther north. This is due to rapidity of growth. There is no humus in the forest belt, and but little litter, which, when present, consists chiefly of broken-down trees.

Fires have run through the entire belt, the piñon areas excepted, at various times in the past. I saw no tracts that had been spared. The damage to the merchantable timber has not been very great, not over 3 per cent. As in the San Jacinto Reserve, the greatest damage has been done to the firs and incense cedars below the 9,000-foot contour. Above that the lodgepole pine has suffered the most, about 60 per cent of the growth being entirely destroyed. In the piñon belt considerable damage has been done in places, but on the whole the destruction here is less than 5 per cent. The chaparral growth has been repeatedly burned over large tracts; in fact, traces of fires exist over the entire brush-covered area. The roots, however, are not often destroyed, and a new growth soon springs up. The reproduction of the forest growth at middle elevations is good. From Green Valley to Strawberry Flat there are good stands of young trees, everywhere ten to twenty years old, to replace the burnt or logged-off areas. The trees are mostly yellow pines and incense cedars. Above the 9,500-foot level the reproduction of the destroyed forest is slow and uncertain. A large quantity of the forest fit for merchantable lumber has been logged off. Sawmills have been in operation for many years. Some of the cutting dates back twenty-five or thirty years. Some is recent, and two sawmills are now running or will soon go into operation. The logged-off areas lie along the main range from Seely Flat to Orchard Canyon. There is also a small tract at the head of City Creek, around the Highland mill, that has been cut over to the extent of 99 per cent.

As in the San Jacinto Reserve, the forest growth has no influence on the run off. The creeks and canyons that head in the portion of the main range where the forest has been logged off show no change in their volume of water. The flow of water from these mountains is regulated by the amount of fissuring of the rocks and, in a lesser degree, by the chaparral holding the mass of loose granitic gravel and sand in place on the steep hillsides.

The yearly precipitation of the region is unknown. I should place it a trifle higher than for the San Jacinto Reserve, or from 20 to 30 inches for elevations between 4,800 and 5,500 feet, and from 30 to 40 inches for elevations between 5,500 and 10,000 feet. The northern slopes of San Bernardino and Grayback peaks, the latter about 11,700 feet in height, carry snow throughout the year.

A. YELLOW-PINE (5,000 TO 10,000 FEET PER ACRE) AREAS NEAR HIGHLAND MILL, SAN BERNARDINO RESERVE.

B. YELLOW-PINE (10,000 TO 15,000 FEET PER ACRE) AREAS NEAR HIGHLAND MILL, SAN BERNARDINO RESERVE.

Altitude 6,000 feet above sea level.

TABLES.

FOREST AREA.

Estimates of the various areas in the San Bernardino Reserve.

[Subject to revision later, the exact northern boundary being unknown to me.]

		Acres.
Approximate area in the San Bernardino Forest Reserve		737,000
Timbered areas	310,000	
Brush-covered areas	370,000	
Desert and naked rocks	40,000	
Meadows, including reservoirs	15,000	
Cultivated tracts	1,200	
Streams, etc	800	
Total		737,000

In the estimates of the timbered areas are included the tracts covered with piñon pines and junipers.

Composition of forested areas.

	Acres.
Class I. Commercial timber areas accessible and carrying more than 1,500 feet merchantable timber per acre	90,000
Class II. Commercial or noncommercial areas hardly accessible, or so only with difficulty, carrying less than 1,500 feet per acre merchantable timber, piñon forest excluded	156,000
Class III. Piñon and juniper forests	64,000
Total	310,000

AMOUNT OF TIMBER.

Amount of merchantable timber other than firewood.

	Feet.
On timber areas of Class I, fair to prime in quality	429,440,000
On timber areas of Class II	50,000,000
On areas of Class III	0
Total	479,440,000

The timber areas of Class I contain most of the merchantable timber. They are situated between the 4,800- and 8,500-foot contours and are generally easy of access. The lands practically all passed out of the hands of the Government long since and are now owned mostly by private individuals. Some of the individual holdings are large; thus, the Higland Mill Company is reported to own over 100,000,000 feet of the accessible timber.

The timbered areas of Class II comprise all lands above the 8,500-foot level and many tracts between the 4,800- and 8,500-foot contours. A great deal of it is rocky and sparsely timbered with undesirable or nonmerchantable species of trees. The quality of timber is poor. Much of it is stunted, twisted, and gnarled, and, being comparatively worthless, the title to most of the lands carrying this kind of forest, not included in the railroad grants, is still vested in the United States.

Class III contains timber fit only for firewood.

SPECIES OF TREES.

Composition of forest, excluding piñon pines, junipers, and deciduous-leaved trees other than oaks.

WESTERN AND SOUTHERN SLOPES OF MAIN RANGE, 3,000 TO 6,000 FEET CONTOUR.

	Per cent.
Pinus ponderosa	64
P. lambertiana	8
P. coulteri	2
Libocedrus decurrens	3
Abies concolor	6
Pseudotsuga macrocarpa	14
Oaks	3

6,000 TO 8,500 FEET CONTOUR.

Pinus ponderosa	52
P. lambertiana	8
P. coulteri	0.5
P. murrayana	1
Abies concolor	30
Libocedrus decurrens	4
Pseudotsuga macrocarpa	0.5
Oaks	3

8,500 TO 11,500 FEET CONTOUR.

Pinus ponderosa	5
P. lambertiana	8
P. murrayana	35
Abies concolor	45
Pinus flexilis	4
Libocedrus decurrens	2
Oaks, etc	1

Composition of piñon forest west of the main San Bernardino Range.

7,000 TO 9,500 FEET CONTOUR.

	Per cent.
Pinus monophylla	50
Juniperus occidentalis	35
Pinus ponderosa	1
Abies concolor	2
Cercocarpus sp., arborescent	10
Oaks	2

Composition of piñon forest on Mohave side of San Bernardino Range.

7,500 TO 9,500 FEET CONTOUR.

	Per cent.
Pinus monophylla	35
Juniperus occidentalis	20
Cercocarpus sp., arborescent	5
Pinus ponderosa	10
Abies concolor	10

NOT ABOVE 7,500 FEET CONTOUR.

Pinus monophylla	93
Juniperus californica, arborescent	5
Yuccas, etc	2

Coniferous trees utilized for lumber.

	Per cent.
Pinus ponderosa	92
P. lambertiana	4
Libocedrus decurrens	3
Abies concolor	0.005

Description of the principal coniferous trees in the reserve.

Coniferous tree.	Description.
Pinus ponderosa (yellow pine).	2 to 5 feet in diameter, 40 to 120 feet in height; clear trunks 20 to 60 feet; trees often remarkably tall and straight; range between 4,800 and 9,000 feet; attains altitudes of 9,800 feet in portions of range fronting on the Mohave Desert; attains its best development for commercial purposes between 4,800 and 8,000 feet; above 8,000 feet, 30 to 50 feet in height, 1½ feet in diameter, with short or no clear trunks.
P. coulteri (Coulter pine)	10 to 20 inches in diameter, 20 to 40 feet in height; no clear trunks; range between 3,900 and 6,000 feet.
P. lambertiana (sugar pine)	2 to 4 feet in diameter, 60 to 80 feet in height; clear trunks 20 to 35 feet; range between 5,400 and 10,500 feet; commercially valuable only below the 9,000-foot contour.
P. monophylla (single-leaf pinon).	8 to 18 inches in diameter; 15 to 40 feet high; no clear trunks; range from 9,500 feet down.
P. murrayana (lodgepole pine).	1 to 4 feet in diameter, the latter size rarely, 20 to 30 feet in height; clear trunks 10 to 20 feet; range chiefly between 9,000 and 11,500 feet, but occasional trees found as low as 7,000 feet above sea level.
P. flexilis (limber pine)	1 to 3 feet in diameter, 20 to 40 feet in height; no clear trunks, or 10 to 15 feet; range between 9,300 and 11,800 feet; timber line tree.
Libocedrus decurrens (incense cedar).	1½ to 3 feet in diameter, 40 to 90 feet in height; clear trunks, commonly none, sometimes 20 to 30 feet; range between 5,000 and 9,500 feet; best development between 5,600 and 7,800 feet.
Psedotsuga macrocarpa (big-cone fir).	1½ to 3 feet in diameter, 40 to 60 feet in height; rarely any clear trunks; range between 3,000 and 6,000 feet.
Abies concolor (white fir)	1½ to 2½ feet in diameter, 30 to 90 feet in height; clear trunks, generally none, even in the largest trees, sometimes in favorable localities 20 to 40 feet; range between 4,800 and 10,000 feet; best development between 5,600 and 8,000 feet.
Juniperus occidentalis (Western juniper).	1 to 4 feet in diameter, 20 to 40 feet in height; no clear trunks; range with the piñon belt.

SAN GABRIEL FOREST RESERVE.

(PRELIMINARY REPORT.)

By JOHN B. LEIBERG.

AREA, TOPOGRAPHY, AND CLIMATE.

The San Gabriel Forest Reserve comprises the Sierra Madre range of mountains. Its exact acreage is not known to me. About 650,000 acres were examined, covering the forest region of the reserve and the larger portion of the chaparral growth. The region is an extremely rugged and broken one. The range has an easterly-and-westerly trend, and the backbone of the ridge that forms the main divide lies well over toward the north and the Mohave Desert. A long westerly slope is the result, and this is cut and gashed in all directions by great gorge-like canyons, sometimes, as in the case of the East Fork of the San Gabriel River, with their bottoms 6,000 to 7,000 feet below the highest summit of the inclosing ridges.

The region comprised within the reserve varies in altitude from 1,000 feet at the mouths of the canyons opening on the plains to 10,000 feet above sea level at the summit of the peak called Old Baldy. The upper slopes of the mountains are steep and rocky and possess comparatively little soil. The valley bottoms are usually narrow, and are commonly covered with bowlders from side to side. Meadows or lands suitable for agriculture are seen but rarely.

The rock formation is chiefly sedimentary and schistose, with a central core of eruptive rock. The sedimentaries have been invaded extensively by dikes of igneous rocks. They are in consequence excessively fissured and tilted. The larger portion of the range is gold bearing. Not much attention seems to have been given to quartz mining, but placers have been worked for years in many localities, notably in the San Gabriel River bottoms, where the wash has been torn up and turned over for distances of many miles. In some places the loose rock and dirt several hundred feet above the present stream beds are being dug out and sluiced.

The soil is sandy, gravelly, or clayey, according to the character of the bed rock prevailing in the vicinity. Where it has sufficient depth it appears to possess considerable elements of fertility.

Below elevations of 5,000 feet the climatic conditions of the reserve are those of a semi-arid region. It is doubtful if the region as a whole receives as heavy precipitation as the neighboring San Bernardino Reserve. There are other conditions here than those of precipitation that influence the forest growth, and therefore the timber is no very reliable guide to the annual amount of moisture the region receives.

VEGETATION.

The native vegetation of the reserve is made up chiefly of the chaparral growth and a low, open, more or less scattered and stunted forest growth. As in the San Bernardino and San Jacinto reserves, the forest begins at the plains level, or nearly so, and consists of narrow fringes of trees—willows, oaks, sycamores, and cottonwoods—bordering the streams. In addition, there is generally a growth of arborescent or semi-arborescent mountain mahogany growing on the dry bowlder wash in the canyon bottoms. On the northern slopes and at the head of the canyons are frequent groves of the big-cone fir, which in this region often descends as low as the 1,500-foot contour. Between elevations of 3,500 and 8,000 feet this tree forms the bulk of the forest growth.

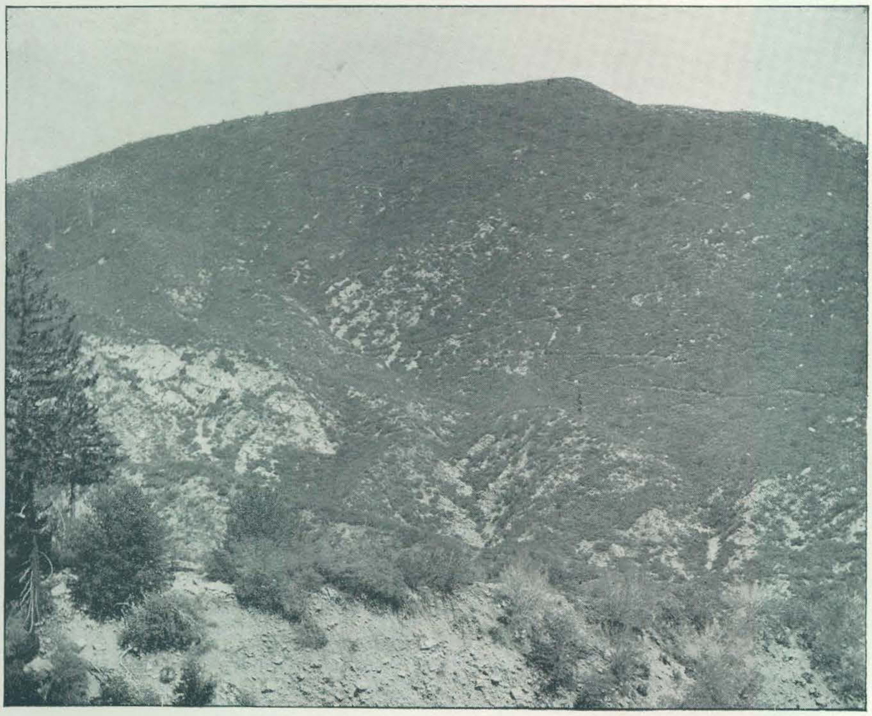
At elevations of 5,500 feet the yellow-pine areas and the forest zone proper begin. It is of an open character everywhere. The trees stand at considerable distances apart, especially on the south-facing hillsides, and they are mostly stunted in growth, owing to the prevalence of high winds and insufficient depth of soil. The forest belt follows the main divide closely and attains to merchantable size and proportions only in a few sheltered localities situated principally on the northern or Mohave side.

The chaparral covers the greater portion of the reserve below the 5,500-foot contour. On the northern slopes of the canyons south of the main range it is often exceedingly dense, attaining far greater dimensions than in either the San Bernardino or the San Jacinto reserves. On the southern slopes it is of medium density, and on the Mohave side it often is thin or almost lacking. It frequently extends far into the forest zone proper, and forms large brush-covered tracts in its midst. The species of shrubs that compose the chaparral are chiefly scrub oaks, "buck brush" (ceanothi), "grease wood" (adenostoma), and suffrutescent forms of mountain mahogany. The grease wood alone forms more than 60 per cent of the total chaparral growth.

The side of the range fronting on the Mohave Desert is usually timbered with an open growth of pine and fir at the highest elevations, giving way to the big-cone fir, single-leaf piñon, and scrub junipers at lower altitudes.

Agricultural lands practically do not exist within the reserve, unless the northern boundary lies far enough out on the Mohave Desert to include the openings of the canyons that discharge in that direction.

A. CHAPARRAL HILLSIDES NEAR HEAD OF LYTLE CREEK, SAN GABRIEL RESERVE.



B. CHAPARRAL HILLSIDES NEAR HEAD OF NORTH FORK SAN GABRIEL RIVER, SAN GABRIEL RESERVE.

A. SLOPES NEAR OLD BALDY, SAN GABRIEL RESERVE, BEARING *Pinus murrayana*, *Abies concolor*, AND *Pinus flexilis*.

Elevation 9,000 to 9,500 feet above sea level.

B. *Pseudotsuga macrocarpa* TIMBER, NORTH FORK SAN GABRIEL RIVER, SAN GABRIEL RESERVE.

At their mouths are areas of level land, suitable for agriculture where water is obtainable. In the interior canyons of the reserve there are occasionally small patches of 2 to 5 acres under cultivation to grass or fruit. The total acreage is insignificant.

Fires have invaded the forested tracts everywhere. The marks of comparatively recent fires are to be seen on every hand. The commercial timber, originally small in quantity, has suffered severely. I estimate that 15 per cent is completely destroyed, and 40 to 50 per cent of the remainder badly damaged by having the lower 8 or 10 feet of the trunks of the trees deeply fire-seared. Among the noncommercial species of trees the big-cone fir has suffered the most. Large tracts once covered with it have been totally laid waste and much of what remains is partially burned or scarred. The chaparral has not escaped. Most of the area covered with this kind of growth exhibits marks of comparatively recent fires. Extensive tracts at the head of Lytle Creek, the North Fork, and the Middle Fork of this stream, and the canyons of the San Gabriel River have been burned over during the last three or four years. As elsewhere in this region, the chapparal generally recovers after a few years, the roots not being burned out, but it is a noticeable fact that the big-cone fir, which forms about 40 per cent of the total forest growth of the reserve, shows but little evidence of recuperation. When destroyed its place is taken by dense thickets of ceanothi and cercocarpus.

It is not at all improbable that a considerable portion of the areas now grown up to brush were in the past covered with a forest of the big-cone fir. The very numerous small groves and individual trees of the species rising from the sea of chaparral would lead one to infer that they represent the remnants of a more extensive forest. It is also noteworthy that the worst-burnt areas in the three reserves examined are to be found in the San Gabriel Reserve in the region of the most extensive mining operations.

The flow of water from the reserve areas depends for its regularity of distribution upon the fissuring of the rocks which form the range. It is altogether probable that there is less precipitation here than in the San Bernardino Reserve or in the San Jacinto Reserve, but nevertheless there is evidently a steadier flow and a larger volume of water here in a given area than in the reserves just mentioned. This is due to the innumerable reservoirs that are formed by the cracks and fissures that abound in the rocks of this reserve and into which precipitation sinks to reappear later and at lower levels as springs and seepage.

There is but little pasturage in the reserve, as the greater area has no grass. A small number of cattle graze in the western portion, and several hundred head of burros range at will on the slopes and throughout the larger canyons, subsisting chiefly on the brush growth.

There has been no extensive timber cutting in the reserve, owing, doubtless, to the inaccessibility of most of the timbered portions. Some cutting for lumber has been done at Rock Creek and in a few other places on the Mohave side of the range. Most of the cutting has been for the purpose of obtaining firewood.

TABLES.

FOREST AREA.

Estimates of the various areas in the San Gabriel Forest Reserve.

		Acres.
Approximate extent of area examined		650, 000
Timbered areas	100, 000	
Brush-covered areas	547, 000	
Streams, etc	3, 000	
Total		650, 000

The timbered areas are the continuous bodies of forest along the main divide and higher laterals. The small groves and scattered individuals of the big-cone fir that occur in the main chaparral belt are excluded from the above estimates.

Composition of the forest areas.

	Acres.
Class I. Commercial timber areas accessible or inaccessible, carrying more than 1,000 feet merchantable timber per acre	25, 000
Class II. Commercial or noncommercial timber areas accessible only with difficulty, carrying less than 1,000 feet merchantable timber per acre	75, 000
Class III. The piñon zone, which in this reserve is composed of stunted, scattered trees of the single-leaf piñon and low juniper scrub. It can not properly be considered as forested areas.	

AMOUNT OF TIMBER.

Amount of merchantable timber other than firewood in the reserve.

	Feet.
On the timber areas of Class I, inferior in quality	50, 000, 000
On the timber areas of Class II, poor in quality	10, 000, 000

Most of the timber in the reserve is fit only for firewood. The above estimates include a great deal that would not be used except under stress of circumstances. Of the timber of Class I, not more than 50 per cent can be considered as accessible.

SPECIES OF TREES.

Composition of the forest.

3,000 TO 6,000 FEET CONTOUR.

	Per cent.
Pinus ponderosa	20
P. lambertiana	Insignificant.
P. coulteri	Insignificant.
P. monophylla	1
Libocedrus decurrens	1
Pseudotsuga macrocarpa	70
Abies concolor	3
Oak and mountain mahogany	4

VIEW AT PINE FLAT, NEAR HEAD OF COLDWATER CANYON, TRIBUTARY OF LYTLE CREEK, SAN GABRIEL RESERVE, CALIFORNIA.

6,000 TO 9,500 FEET CONTOUR.

	Per cent.
Pinus flexilis	4
P. ponderosa	20
P. murrayana	8
P. monophylla	1
P. lambertiana	8
Pseudotsuga macrocarpa	20
Libocedrus decurrens	3
Abies concolor	35
Oak, etc	1

Coniferous trees utilized for lumber.

	Per cent.
Pinus ponderosa	99.99
P. lambertiana Libocedrus decurrens	.01

Description of the principal coniferous trees in the reserve.

Coniferous tree.	Description.
Pinus ponderosa (yellow pine)	1 to 2 feet in diameter, 30 to 60 feet in height; clear trunks 10 to 20 feet; range between 5,500 and 9,000 feet.
P. coulteri (Coulter pine)	A few trees seen at 5,000 feet elevation.
P. lambertiana (sugar pine)	1 to 3 feet in diameter, 20 to 50 feet in height; clear trunks 10 to 20 feet; range between 6,500 and 8,500 feet.
P. monophylla (single-leaf piñon).	8 to 12 inches in diameter, 15 to 20 feet in height; no clear trunks; range from 7,500 feet down.
P. murrayana (lodgepole pine)	1 to 2 feet in diameter, 20 to 60 feet in height; clear trunks 10 to 40 feet or none; range between 7,500 and 10,000 feet, sometimes occurs at 3,000 feet.
P. flexilis (limber pine)	1 to 3 feet in diameter, 8 to 25 feet in height; clear trunks, none or 4 to 10 feet; range between 8,000 and 10,000 feet.
Libocedrus decurrens (incense cedar).	1½ to 2½ feet in diameter, 50 to 90 feet in height; no clear trunks; range between 5,000 and 8,000 feet.
Pseudotsuga macrocarpa (big-cone fir).	1 to 5 feet in diameter, 30 to 60 feet in height; clear trunks, usually none or 10 to 15 feet; range between 1,500 and 8,500 feet. The most abundant tree in the reserve, and of the widest altitudinal range.
Abies concolor (white fir)	1½ to 2 feet in diameter, 40 to 70 feet in height; clear trunks, none or 12 to 30 feet; range between 5,000 and 10,000 feet.
Sequoia sempervirens (sequoia).	Reported as occurring in small numbers in the reserve. None were seen by me, and no one could be found who knew of the place of growth.

PRESENT CONDITION OF THE FORESTED AREAS IN NORTHERN IDAHO OUTSIDE THE LIMITS OF THE PRIEST RIVER FOREST RESERVE AND NORTH OF THE CLEARWATER RIVER.

By JOHN B. LEIBERG.

GENERAL ASPECTS OF THE FOREST.

In the examination of the Priest River Forest Reserve it was seen to what extent that section has been ravaged by recent forest fires. That it may not be supposed that the destruction there has been more widespread than elsewhere, the results of an examination into the conditions of the forest on the areas to the east and south of the reserve will also be given. It will be seen that the Priest River region has not suffered more severely than any other, but that, on the contrary, the entire northern portion of the State is involved in the common ruin.

THE FOREST AS IT WAS.

The northern portion of Idaho, previous to settlements of a permanent character, was covered with a great, almost unbroken, forest. Numerous references to the difficulties experienced in traveling through, owing to its density, are to be found in the itineraries of the early Government expeditions for railroad routes to the Pacific. Forest fires, as a matter of course, were not unknown, but the burns were of small extent, were not numerous, and those resulting from large fires, back as far as one hundred or one hundred and fifty years, were well along on the recuperative stage. The total forested area north of the Clearwater River, in what is now the State of Idaho, comprised about 6,000,000 acres, out of an estimated total of 6,500,000 acres for the entire region. The forest as it stood on this large tract did not, of course, consist entirely of merchantable timber, but the growth as a whole was nevertheless valuable and important.

The character of the forest in this region is peculiar. The forest is situated in an area subject to extremely heavy annual precipitation, and with soil rich in all the elements of plant growth. In average productiveness it greatly surpasses the forests of the Upper Mississippi

Basin. In the actual quantity of woody growth per acre it compares favorably with the regions west of the Cascades in the same latitude and at the same elevation. The bulk of the merchantable timber ranges in age from 150 to 250 years. Here and there were found bodies of old growth—300 to 800 years old—immensely productive. Small tracts of this kind of forest were seen by the writer fourteen years ago in the region between the headwaters of the St. Mary and the northern tributaries of the North Fork of the Clearwater, that would easily yield above 300,000 feet B. M. per acre. Fires have long ago demolished these phenomenal forest growths, with many lesser ones.

The forest of the region is composed almost wholly of cone-bearing trees, and, without exception, of species different from those that make up the coniferous growths in the Upper Mississippi Basin. Its affinities lie wholly with the forests west of the Cascades, although some of the species of trees occurring there are lacking in this region. There is considerable difference, however, regarding the preponderating development of any given species, for while the red fir takes chief rank in the Cascade forests in this latitude, the western white pine and the western tamarack furnish the bulk of the forest growth in the northern Idaho region.

The forest exhibits three distinct general types. They are: (1) The yellow-pine zone; (2) the western white-pine zone; (3) the subalpine-fir zone. Owing to the infinite varieties of local climatic conditions that are found throughout the mountains, these zones or types are not at all times clearly differentiated, except in the largest aspects. Along their upper and lower limits they frequently overlap and intermingle, the determining factor of distribution below the 5,000-foot level being mostly that of moisture, while above that elevation the mean annual temperature seems to play the chief part.

The general distribution of the three zones is as follows: The zone of the yellow pine is found on all the approximately level areas fronting on and adjacent to the plains of the Columbia, extending on the southern slopes and drier bottom lands along many of the larger valleys considerable distances into the mountains. In its altitudinal range the greater portion does not extend above 2,900 feet, although on warm, dry slopes with southern exposure it may go as high as 4,700 feet. The growth is open, and consists mainly of yellow pine on the drier areas; but in localities with more moisture supply it frequently becomes very dense and consists of a mixed growth of red fir, white fir, western tamarack, and lodgepole pine.

The white-pine zone is the most common and covers the largest area. It lies mainly below the 5,000-foot level. Its chief species of trees are the western white pine and the western tamarack. It is usually more or less mixed with varying percentages of cedar, hemlock, and Engelmann spruce. On south-facing slopes and along the larger valleys considerable quantities of the red fir and lodgepole pine are frequently found within the limits of the zone, and in swampy localities immense growths of cedar. This type of forest is by far the most productive in the three divisions, and is the distinctive type of the silva in the region under consideration.

The subalpine zone includes most of the areas above the 5,000-foot level. It is not a continuous forest, being broken at intervals by grassy slopes or rocky crests, where insufficiency of soil prevents the growth of timber. It is, in the main, composed of two species of trees—namely, the subalpine fir and the white-bark pine. In some of the southern areas there is also frequently an additional species in the Patton hemlock, which would be valuable if it grew in accessible places. Reckoning the entire area of the various forest zones at 6,000,000 acres, there would be included within the zone of the yellow pine about 1,390,000 acres, within the zone of the white pine about 3,720,000 acres, and within the subalpine zone about 890,000 acres.

RAPINE OF THE FOREST.

The chief purpose of this paper is to give an approximate estimate of the amount of timber destroyed by fire over a considerable continuous area west of the Rocky Mountains during the last thirty-eight years, and for this purpose the region under consideration has been chosen, because, in most of its parts, it is well known to the writer, and, further, is on the whole a conspicuous example of the treatment of the western forest areas.

In forming estimates, the following methods have been employed: For areas, the region has been divided into districts corresponding in a general way with the natural drainage basins of the principal streams. All areas above 5,000 feet have been reckoned as coming within the subalpine zone. The divides and lateral offshoots of them that reach this altitude and over have been traced, and their areal extent calculated. The tracts assigned to the white- and yellow-pine zones have been estimated wholly from personal knowledge of the region, and while the totals are closely correct, it must be admitted that it is impossible to assign the precise acreage belonging to each without definite surveys. The stand of timber, living and burned, has been computed on the following basis: In the yellow-pine zone all yellow pine above 12 inches basal diameter, and all other species above 8 inches basal diameter, are included, with the exception of the lodgepole pine, which, in this zone, is not taken into account at all. In the white-pine and subalpine zones all timber above 8 inches basal diameter is included. Portions within the distinctive crown of the trees are not computed. The burnt tracts have been estimated on the basis of the amount of timber the adjacent unburnt areas now carry. The estimates of destruction also embrace the quantities that have been cut for all purposes. In the final tabulation allowance will be made for this consumption. The entire account is derived from the writer's acquaintance with the region during a period of more than fourteen years, and the estimates are in every respect along conservative lines.

The destruction in the Priest River Basin has already been noted in the report on the forest conditions in that region. Going east from the Priest River Forest Reserve, there is first the long eastern slope of the mountain range that bounds this reserve on the east. The slope ends in a large, approximately level tract of country, rather swampy in character, and is bounded on the north by the Kootenai River, on the south by Lake Pend Oreille, and on the east by the western front of the mountain mass that separates the tributaries of the Kootenai from those of the Clark Fork.

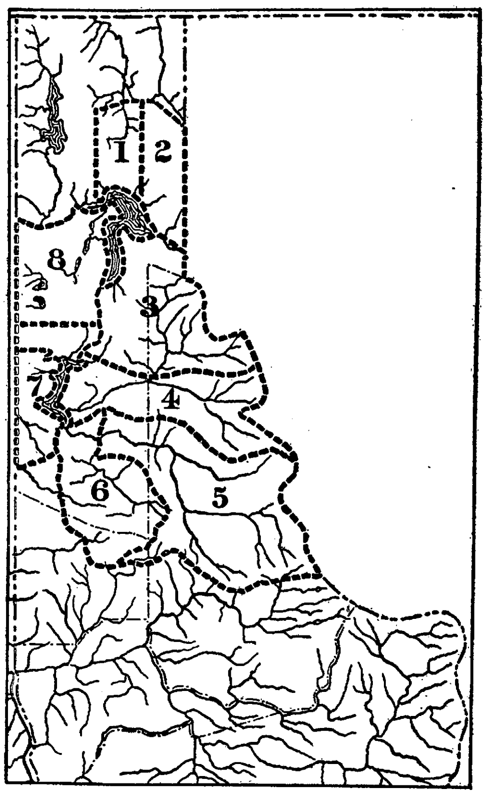


FIG. 2.—Map of northern Idaho, showing districts.

The forest on the level tracts consisted principally of the western white-pine type, on the lower slopes the same, and on the summits of the ridges the subalpine one. About 15 per cent was covered with yellow pine. Various tracts contained open growths of small lodgepole pine, but in general the stand of timber was heavy, especially in the numerous cedar groves and bottoms that were found throughout. The tract will be designated—

DISTRICT NO. 1.

	Acres.
Total forest area in the district	275,000
Subalpine type	15,000
White-pine type	217,000
Yellow-pine type	43,000
	Feet B. M.
Total original stand of timber	7,205,000,000
Subalpine stand	30,000,000
White-pine stand	6,960,000,000
Yellow-pine stand	215,000,000
Destruction	5,764,000,000
In the subalpine stand	25,000,000
In the white-pine stand	5,574,000,000
In the yellow-pine stand	165,000,000

The larger portion of this district is well situated for rapid reforesting, but the process is proceeding slowly. This is entirely due to the annually recurring fires in the young growth. There is such an enormous quantity of litter, representing the dead and only partially consumed original growth, yet remaining on the ground, that fires have a good chance to run over large tracts, and they destroy the young saplings struggling to replace the consumed timber. At the present time the area is a nidus for forest fires throughout the summer and fall.

To the east of the district lies the mountain divide that separates the Kootenai River Basin in part from that of the Clark Fork. It is a rugged region of considerable altitude, and a large percentage is included within subalpine limits. Much of the region is rocky and did not support a very good stand of forest. Certain areas, especially in the Clark Fork Valley, contained heavy bodies of timber, but in general it was one of the lightest timbered areas in our region. The tract will be designated—

DISTRICT NO. 2.

	Acres.
Total forest area in the district	295,000
Subalpine type	118,000
White-pine type	162,250
Yellow-pine type	14,750
	Feet B. M.
Total original stand of timber	1,816,900,000
Subalpine stand	164,900,000
White-pine stand	1,622,500,000
Yellow-pine stand	29,500,000
Destruction	1,271,830,000
In the subalpine stand	115,430,000
In the white-pine stand	1,135,750,000
In the yellow-pine stand	20,650,000

Reforesting in this district is proceeding at a much slower rate than in District No. 1. Many of the subalpine tracts that are above the line of heavy brush have become covered with grass, sedge or "bear grass." The south-facing slopes, owing to their steepness, are fast losing their soil covering where the timber has been burned. The bench lands in the Clark Fork Valley appear to have become too arid to permit a general renewal of the forest growth. The canyons that head in the range and flow into the Clark Fork are scouring out their channels and bringing their accumulations of sand and gravel into the main valley. In isolated localities the young growth is gaining a little, but here, as in the previous district, fires occur during the dry season in the débris that litters the ground, and large quantities of saplings are thus destroyed.

Passing southward across the Clark Fork, the basin of the North Fork of the Cœur d'Alene River is reached. Here begin the once heavily forested tracts and the present great burns of the region. The forest destruction has been immense, and has followed closely the limits of the known mineral-bearing regions. The entire forest in the southeastern portion of the basin, where the gold-bearing districts are situated, is nearly wiped out. In the northern sections the fires from the valley of the Clark Fork have destroyed it to the extent of fully 60 per cent. In the northern half of the western areas fires originating along the east shore of Lake Pend Oreille have swept large tracts almost bare of living timber. In the entire basin there exists but one area in a fair state of preservation, a tract of about 140,000 acres in the southwest corner, on which the damage does not much exceed 10 per cent. The basin will be designated—

DISTRICT NO. 3.

	Acres.
Total forest area in the district	691, 200
Subalpine type	110, 000
White-pine type	540, 000
Yellow-pine type	41, 200
	Feet B. M.
Total original stand of timber	16, 373, 000, 000
Subalpine stand	165, 000, 000
White-pine stand	15, 503, 000, 000
Yellow-pine stand	705, 000, 000
Destruction	9, 028, 000, 000
In the subalpine stand	132, 000, 000
In the white-pine stand	8, 403, 000, 000
In the yellow-pine stand	493, 000, 000

In the areal estimates of this district there are included the western slopes of the west inclosing ridge as far south as the south end of Lake Pend Oreille, and the northern slopes of the north inclosing ridge to the south bank of the Clark Fork.

Reforesting in this district is proceeding rapidly on all slopes that face the north, less rapidly on the crests of the ridges, and slowly or not at all on the south-facing slopes. In the southeastern sections the young growth is mostly fired as fast as litter enough accumulates to support a conflagration. The areas facing west on the slopes to Lake Pend Oreille are becoming covered chiefly with dense brush growths, and where the angle of slope is very great the soil is either sliding off into the lake directly or into the beds of the streams in the canyons.

South of District No. 3 lies the valley of the South Fork of the Cœur d'Alene. The valley has been a link in the highway between the regions east of the Rockies and the plains of the Columbia since late in the fifties, and is now the scene of the largest mining operations in this portion of the State. The forest has been effectually removed. In the early days of settlement it was considered a great detriment to the rapid and economical development of this section of country, and fires were therefore started in hundreds of places during a series of years to clean off the troublesome forest. It is now so well removed that it will never again be in the way. Throughout the entire section the subalpine and white-pine stands are practically destroyed. The young growth that has at various times struggled to replace the burned has been fired so often that there is comparatively little to be seen. The yellow-pine areas have not suffered so much as the others. Originally a large portion of the basin was covered with that type of forest, especially on the areas west of the Old Mission in the main valley of the Cœur d'Alene. The fire destruction in this belt of timber has been confined mainly to the long lobes of the white-pine zone projecting at various points along the streams into the yellow-pine areas. Much of the yellow pine has been logged off, and in so far has been preserved against consumption by fire—apparently the near-by fate of the remainder. The basin of the South Fork will be designated—

DISTRICT NO. 4.

	Acres.
Total forest area in the district	547,960
Subalpine type	72,000
White-pine type	167,960
Yellow-pine type	308,000
	Feet B. M.
Total original stand of timber	9,387,600,000
Subalpine stand	144,000,000
White-pine stand	6,779,600,000
Yellow-pine stand	2,464,000,000
Destruction	7,498,000,000
In the subalpine stand	120,000,000
In the white-pine stand	6,134,000,000
In the yellow-pine stand	1,244,000,000

Reforesting is making but scant headway in the district. Most of the south-facing slopes have yet no appreciable amount of young timber, and not a great deal of brush. Aridity, due to excessive evaporation and an acceleration in the run-off, is everywhere apparent. The north-facing slopes have in some localities a tolerably fair stand of young growth, but more or less is fired every summer, and the chance for the reappearance of extensive bodies of growing forest is extremely small under the present conditions.

Passing southward from the valley of the South Fork of the Cœur d'Alene, we enter the basin of the St. Joseph River. It is the largest in area of the Cœur d'Alene watersheds, and contains the greatest quantity of living forest at the present time. It is composed of two drainage basins, the main, St. Joseph, with its three forks, the North, Middle, and South, and the St. Mary. For purposes of closer estimates the two main valley systems will be treated separately.

The region drained by the St. Joseph is rugged and mountainous. Many of the divides between the principal affluents reach well up toward the 7,000-foot level. Considerable tracts at this elevation are devoid of timber, forming instead open expanses covered with grass, mountain sedges, or the so-called bear grass (*Xerophyllum tenax* Pursh.). These open tracts are in nearly every instance the after effects of forest fires that occurred centuries ago. The charred stumps that still remain on these tracts prove such to be the case. The after effects of the modern burns at these elevations, when reforesting does not take place, is a dense sward formed by various species of rush, mainly *Juncoides glabratum*. Elevations of 6,000 feet and upward in the St. Joseph Basin are above the line of heavy brush growth, in either the forested or the deforested sections, from which it follows that the burnt areas at such altitudes do not grow up to brush. They become covered with young timber of the subalpine type, or remain as open slopes bearing the kind of vegetation already mentioned. The ridges at the heads of the Middle Fork and South Fork of the river have been subjected to extensive glaciation and contain areas of bare, rocky crests. The subalpine forest in the basin is of much heavier growth, on an average, than elsewhere in the State. This is due to the abundant occurrence of Patton hemlock, a tree which forms dense stands at the highest elevations within the section where a sufficiency of soil exists. The larger valleys of the basin are swampy in many places, and have or had a very heavy growth of the common species of the white-pine type of forest.

Forest fires have laid the region under contribution in many places. The burnt-over areas are not so large and continuous as in the valley of the South Fork of the Cœur d'Alene. They occur as isolated burns in hundreds of localities, and collectively amount to many thousands of acres. Placer mines were worked at the heads of the Middle and South forks of the stream in the sixties and later. Well-traveled trails led along the higher divides north and south, and east and west, and the forest suffered in consequence. The St. Joseph Basin will be designated—

DISTRICT NO. 5.

	Acres.
Total forest area in the district	955,000
Subalpine type	270,000
White-pine type	620,000
Yellow-pine type	65,000
	Feet B. M.
Total original stand of timber	22,770,000,000
Subalpine stand	1,080,000,000
White-pine stand	21,300,000,000
Yellow-pine stand	390,000,000
Destruction	7,077,000,000
In the subalpine stand	648,000,000
In the white-pine stand	6,390,000,000
In the yellow-pine stand	39,000,000

Reforesting in this district is progressing along the same lines as elsewhere. The southern slopes display aridity and deficiency of young growth. The northern slopes have good stands in many places, and the lower crests present dense brush growths. During the last few years there have been fewer fires, perhaps, in this district than elsewhere, considering the quantity of forest still remaining, and the young growth has stood a better chance for its life.

South of the St. Joseph Basin lies that of the North Fork of the Clearwater. The area drained by this stream is, or was, as heavily timbered as the one we have just examined. Its actual condition at the present time is not known to the writer and is therefore reserved for a future paper.

The other and the smaller portion of the St. Joseph Basin is the basin of the St. Mary. The subalpine type of forest is not extensively represented here, the greater portion of the region lying below the 4,500-foot level. Near the confluence with the St. Joseph there are considerable tracts of the yellow pine, but the chief forest area consists of the western white-pine type. The basin originally contained the largest continuous body of old growth in the northern portion of the State.

Fire destruction has been excessive. In this case it has not followed mining developments, for no known mineral deposits of value exist here. Since 1886 fires have spread almost wholly from the agricultural holdings along the main valley. Previous to that time they owed their origin to the prospector, the hunter, and the trapper.

In the areal estimate of the basin the portion of the St. Joseph is included which lies between the junction of the two streams and the outlet of the St. Joseph into Cœur d'Alene, which was excluded from the estimate of District No. 5. The St. Mary region will be designated—

DISTRICT NO. 6.

	Acres.
Total forest area in the district	536, 000
Subalpine type	26, 800
White-pine type	428, 800
Yellow-pine type	80, 400
	Feet B. M.
Total original stand of timber	20, 289, 880, 000
Subalpine stand	2, 680, 000
White-pine stand	19, 644, 000, 000
Yellow-pine stand	643, 200, 000
Destruction	16, 170, 180, 000
In the subalpine stand	2, 000, 000
In the white-pine stand	15, 814, 420, 000
In the yellow-pine stand	353, 760, 000

The district is exceptionally well situated for rapid reforesting. Its direction is north and south, as regards its long diameter, and a minimum of its mountain slopes is exposed to the south. Its soil is deep, and it is well watered. Nevertheless, the young forest is not abundant. Large tracts, burned twenty or twenty-five years ago, are still covered with immensely dense brush growths, in which the reforesting process is but fairly begun. Fires spreading from the clearings, or set by design to promote the grass growth every summer, run through the young timber and what remains of the old, and it will not be long before the district is practically swept clear of forest.

The country to the west of the St. Mary Basin contains the headwaters of the Palouse River, with some portions of the Spokane River drainage through Hangman Creek. The total forest area in this section amounts to over 300,000 acres. The present status of the forest is not known to me. Large tracts have been burned over, much has been cut for lumber, and a considerable acreage has been cleared for purposes of agriculture. The percentage of timber removed or destroyed is doubtless very large.

On the areas west of the mountains, fronting directly on the open plain, a large proportion of the stand of timber belongs to the yellow-pine type, and has not suffered so seriously as the white-pine and the subalpine types in the mountain regions, not because fires have been lacking, but solely because the timber in this type of forest is not so readily injured or destroyed as in the two other types.

Proceeding northward from the region referred to, a strip of plain, extending east from the main areas farther west, is first met. It is nearly devoid of timber, a few small tracts scattered on the slopes of some of the outlying hills constituting the forested acreage. Passing still farther north, a small strip of the yellow-pine type and a limited area of subalpine aspect are reached, situated between the Spokane

River and the first route of the Mullan road around the south end of Lake Cœur d'Alene. The tract is designated—

DISTRICT NO. 7.

	Acres.
Total forest area in the district	145,000
Subalpine type	5,000
Yellow-pine type	140,000
	Feet B. M.
Total original stand of timber	845,000,000
Subalpine stand	5,000,000
Yellow-pine stand	840,000,000
Destruction	425,000,000
In the subalpine stand	4,500,000
In the yellow-pine stand	420,500,000

A very large portion of this timber, estimated as destroyed, has been logged for lumbering purposes or removed to clear the ground for agricultural operations, for which the region is well fitted. On the whole, it may be considered that the destruction of the forest in this district has resulted in greater gain in other directions than the value of the timber removed, a condition not to be found elsewhere in the region.

Immediately to the north of this district lies another section of country naturally devoid of timber. It is what is known as the Spokane Prairie, a continuation of the plains of the Columbia eastward along the Spokane River. The forest begins again along a line drawn east and west through a point about 2 miles south of Rathdrum, in Idaho. Thence northward to the Clark Fork the country is of a rolling character, isolated mountain ranges of no great height cutting it here and there. The level areas are intersected by many old channels of the Clark Fork, cut during glacial times, when this stream emptied its waters into the present valley of the Spokane. These abandoned channels hold water in many places, and constitute numerous small lakes and ponds. The larger portion of the forest was of the yellow-pine type. The presence of the small lakes favored the development of the white-pine type to some extent, and the summits of the short ranges afforded circumscribed tracts of the subalpine zone.

The district appears to have been peculiarly exposed to destructive fires far back in time, to judge from the extensive bodies of lodgepole pine that occur at frequent intervals. Modern years have furnished conflagrations enough to wipe out all the heavy white-pine forest and much of the other types.

The tract constitutes—

DISTRICT NO. 8.

	Acres.
Total forest area in the district	520,000
Subalpine type	52,000
White-pine type	160,000
Yellow-pine type	308,000

	Feet B. M.
Total original stand of timber	6,106,000,000
Subalpine stand	104,000,000
White-pine stand	3,000,000,000
Yellow-pine stand	3,002,000,000
Destruction	4,183,120,000
In the subalpine stand	103,000,000
In the white-pine stand	2,880,000,000
In the yellow-pine stand	1,200,120,000

Reforesting is proceeding slowly in the white-pine areas; not at all in the subalpine ones, and rapidly on the yellow-pine lands when fires are kept down. The yellow-pine zone in this district is grassed throughout and fires are of very frequent occurrence during the summer and fall. In consequence, the young growth in the zone stands but a small chance of attaining valuable dimensions.

There remains unexamined the region north of the Kootenai River. The condition of its forest covering is unknown to me, except as a matter of hearsay. It is said to average about the same as the timber in District No. 3, the basin of the North Fork of the Cœur d'Alene, but as our information is not very definite all estimates relative to the tract are excluded.

AMOUNT OF TIMBER.

Estimate of standing timber, by districts.

SUBALPINE TYPE OF FOREST.

District.	Area.	Stand of timber.	Amount destroyed.
	Acres.	*Feet B. M.*	*Feet B. M.*
No. 1	15,000	30,000,000	25,000,000
2	118,000	164,900,000	115,430,000
3	110,000	165,000,000	132,000,000
4	72,000	144,000,000	120,000,000
5	270,000	1,080,000,000	648,000,000
6	26,800	2,680,000	2,000,000
7	5,000	5,000,000	4,500,000
8	52,000	104,000,000	103,000,000
Total	668,800	1,695,580,000	1,149,930,000

WHITE-PINE TYPE OF FOREST.

District.	Area.	Stand of timber.	Amount destroyed.
No. 1	217,000	6,960,000,000	5,574,000,000
2	162,250	1,622,500,000	1,135,750,000
3	540,000	15,503,000,000	8,403,000,000
4	167,960	6,779,600,000	6,134,000,000
5	620,000	21,300,000,000	6,390,000,000
6	428,800	19,644,000.000	15,814,420,000
7			
8	160,000	3,000,000,000	2,880,000,000
Total	2,296,010	74,809,100,000	46,331,170,000

Estimate of standing timber, by districts—Continued.

YELLOW-PINE TYPE OF FOREST.

District.	Area.	Stand of timber.	Amount destroyed.
	Acres.	*Feet B. M.*	*Feet B. M.*
No. 1	43, 000	215, 000, 000	165, 000, 000
2	14, 750	29, 500, 000	20, 650, 000
3	41, 200	705, 000, 000	493, 000, 000
4	308, 000	2, 464, 000, 000	1, 244, 000, 000
5	65, 000	390, 000, 000	39, 000, 000
6	80, 400	643, 200, 000	353, 760, 000
7	140, 000	840, 000, 000	420, 500, 000
8	308, 000	3, 002, 000, 000	1, 200, 120, 000
Total	1, 000, 350	8, 288, 700, 000	3, 936, 030, 000

SUMMARY.

Type.	Area.	Stand of timber.	Amount destroyed.
	Acres.	*Feet B. M.*	*Feet B. M.*
Subalpine	668, 800	1, 695, 580, 000	1, 149, 930, 000
White pine	2, 296, 010	74, 809, 100, 000	46, 331, 170, 000
Yellow pine	1, 000, 350	8, 288, 700, 000	3, 936, 030, 000
Total	3, 965, 160	84, 793, 380, 000	51, 416, 130, 000

The amounts of timber standing and destroyed given above represent, as before stated, the entire growth above 8 inches basal diameter, excluding the lodgepole-pine forest in the yellow-pine zone. This growth has been left out from the estimates because it is mostly low and shrubby and of uncertain quantity in any given area. In the white-pine and subalpine types of forest the lodgepole pine attains sufficient size to display clear trunks, becomes of commercial value, and also becomes more definite in quantity; it is then, accordingly, included in the estimates. As to the commercial values of the original growth of standing timber, about 75 per cent may be regarded as a fair estimate, which gives 63,595,035,000 feet B. M. as the total for this class of timber originally—that is, previous to 1860. About 50 per cent, or 31,797,517,500 feet, may be regarded as coming within the classification of "accessible timber," and about 60 per cent of this amount, or 19,077,510,500 feet, as forming saw timber. Of the timber destroyed, a portion has been utilized. How much can not be estimated with any great degree of accuracy, for no data are available. It might be said that 8,000,000,000 feet covers all, lumber consumption, clearings, fencing, etc. This would leave 43,416,130,000 feet as destroyed through fire and its after effects.

The estimates are regarded as strictly within the true limits. If the methods employed in the computations had been rigidly interpreted, it is not doubted that the totals would have been swelled considerably above the amounts given.

THE FUTURE.

There can be no doubt as to what the future will bring. The complete destruction of the forest in this region as a commercial factor is beyond question, unless the forest is placed at once under effective supervision. At the present time less than 40 per cent of the burnt areas are reforesting, and sections carrying the young growth are reburned annually. Sixty per cent are either in the brush stage or would be entirely barren but for small quantities of coarse grasses or weeds. These tracts will nearly all reforest in time, but to accomplish this result fires must be kept down.

The forest conditions prevailing in northern Idaho merely foreshadow future forest conditions elsewhere in the wooded districts in the West.

PINE RIDGE TIMBER.

By N. H. Darton.

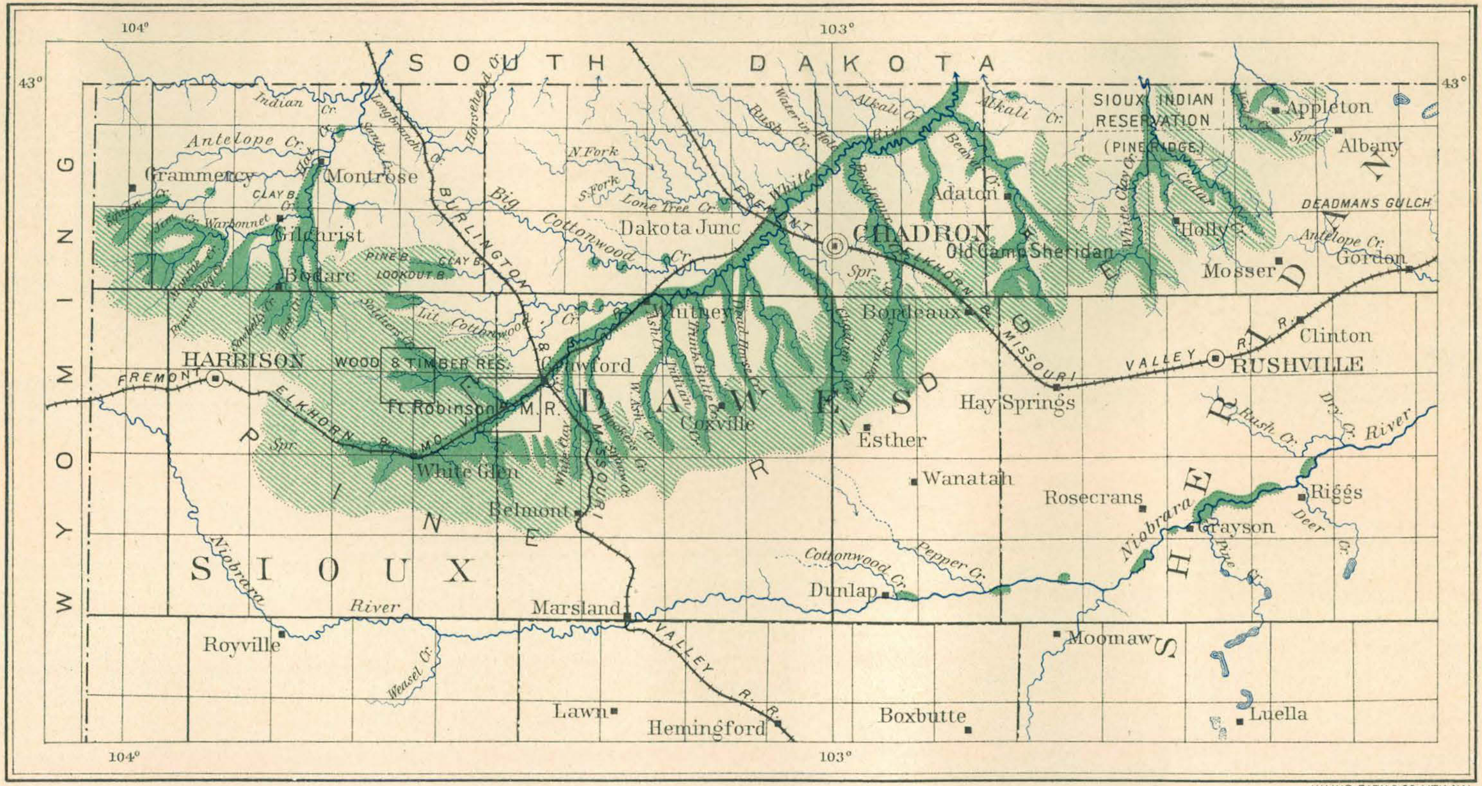
Pine Ridge crosses the northwest corner of Nebraska in Sioux and Dawes counties. It is the escarpment of the high table-land constituted by the younger formations of the Great Plains at the southern margin of the Black Hills uplift. The escarpment faces the north, and its cliffs and steep slopes descend about 1,000 feet from the tabular surface of the plains to the wide valley extending from White River across the low divide to the South Fork of the Cheyenne River at the southern foot of the Black Hills. Its altitude is about 5,000 feet at the Wyoming line, and it slopes gradually to the east. To the south there is a gentle slope to the elevated valley of the Niobrara River. Along the face of this great escarpment there is an extensive zone of the Rocky Mountain pine, *Pinus ponderosa*, which varies in width from 1 to 4 miles. The timber begins on the crest of the escarpment and extends down for 600 or 700 feet on the northern slopes. The gentle southerly slope toward the Niobrara River is treeless. There are many canyons in the face of the escarpment containing small streams bordered by groves of deciduous trees, mainly the cottonwood and the box elder. A typical view of one of these canyons, showing the higher pine-clad slopes, is given in Pl. CIX. It gives a typical view also of the average pine growth. The amount of pine timber on Pine Ridge is only moderately large, but it is a most important source of supply for lumber and firewood for a large area. Much has been cut, and although the young pine grows vigorously, the cutting exceeds the growth in most portions of the district.

The timber is not so thick as in portions of the Black Hills, but the trees attain equally large size. As the escarpment consists largely of cliffs and steep slopes, many of the trees are in places not convenient for the lumberman.

Fire has done little damage along the face of the ridge, and traces of recent fires are very rarely found.

The United States has a timber reservation in the area, comprising about 10 square miles, near the head of Soldiers Creek, west of Fort Robinson.

NORTHERN SLOPE OF PINE RIDGE, SOWBELLY CANYON, SIOUX COUNTY, NEBRASKA.



Pine timber

Cottonwood, Boxelder and other deciduous timber

DISTRIBUTION OF TIMBER IN NORTHWESTERN NEBRASKA

BY N. H. DARTON 1898

Scale of miles

0 10 20 30 40

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C.

M.

N.